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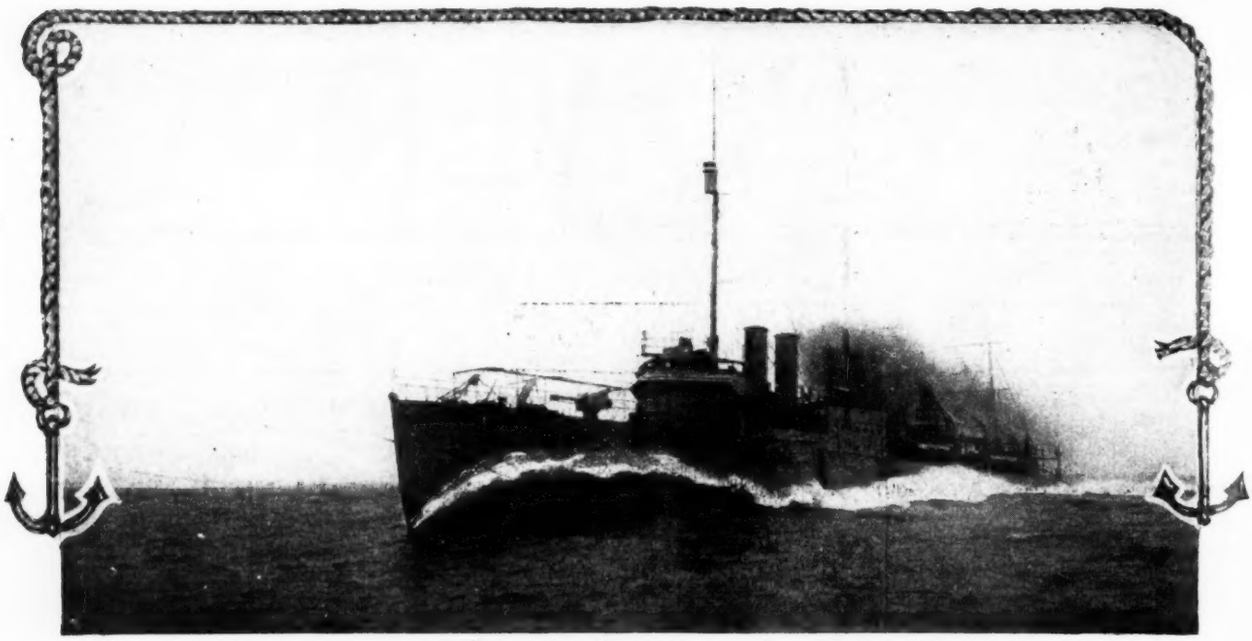


U. S. TORPEDO BOAT DESTROYER "RIED" BUILT IN SIXTY ELAPSED DAYS FROM LAYING OF KEEL TO LAUNCHING

Monel-Metal Blades in Destroyer Turbines

By W. F. RICE
Bethlehem Shipbuilding Corporation, Limited

BEFORE the reduction gear came into general use in connection with turbine installation, slow-speed turbines were used, mounted directly on the driving or propeller shafts, and the maximum speed in these turbines rarely exceeded 600 r.p.m., with a consequent low centrifugal force. To resist corrosion, composition buckets were used in their construction, and this metal also proved amply strong to resist all strains due to centrifugal force to which the buckets were subjected. With the advent of the reduction gear the high-speed turbines superseded the slow-speed turbines, resulting in a far more satisfactory and efficient installation throughout. With the adoption of high-speed turbines it became necessary to change the design of the machine radically, particularly the construction of the blading, to withstand the tremendous pull that was exerted by the centrifugal force caused by the great increase in speed. It was found that the composition blades which had heretofore been used had not the physical properties to withstand the strains to which they would be subjected at high speeds, although they were satisfactory to the extent of being non-corrosive.

In this connection it may be interesting to note that to comprehend the force to be reckoned with in considering the centrifugal force set up in these high-speed turbines, a one-pound weight or blade weighing one pound, attached to the rim of a turbine wheel, will, when running at a test speed, exert a force or pull of 11,100 lb.; this, reduced to a tensile equivalent, would be over 20,000 lb. per square inch.

It was necessary, in view of the additional strength of the metal required for the turbine blading, to select

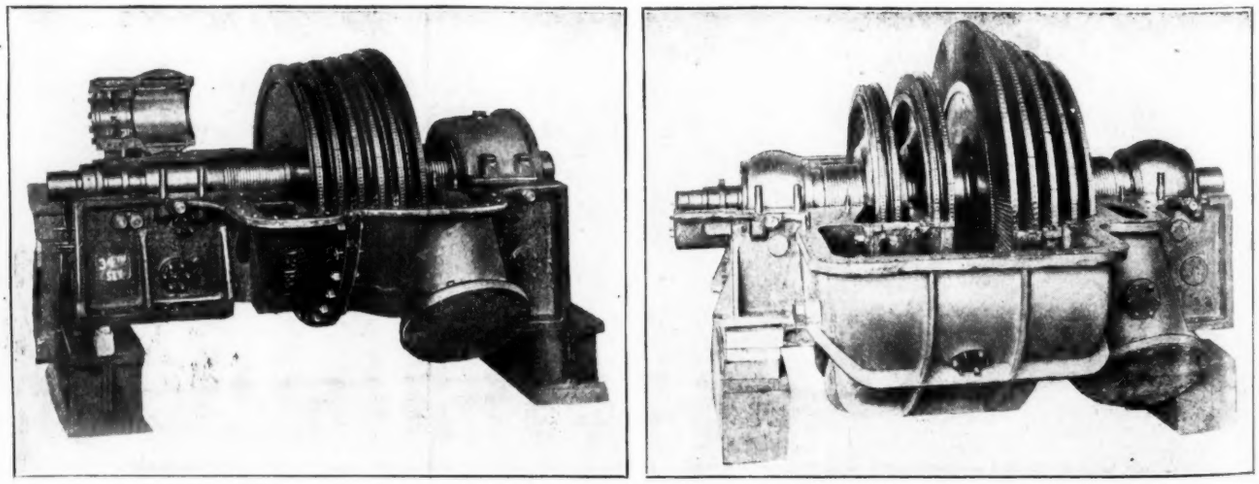


FIG. 1. EACH OF THE DESTROYERS BUILT DURING THE WAR HAS SIX TURBINES—TWO HIGH, TWO INTERMEDIATE AND TWO LOW PRESSURE—DEVELOPING 30,000 HP. PER BOAT

some metal that would be non-corrosive and yet which would have the physical properties of steel. In addition to the two prme requirements—strength and non-corrosive qualities—the metal selected must have ductility to withstand sudden shock. It must also withstand the erosive effect of high-pressure steam. It must withstand the effect of high temperatures without impairing its strength and finally, it should lend itself in manufacture to the forging process as well as to machining from the bar stock. Monel metal appeared to fill all of the foregoing requirements. It had already been used to some extent for propeller blades, valves, valve seats and other miscellaneous uses where strength and non-corrosive qualities were required, and had given satisfactory results. In view of this it was felt that it would be an excellent material for use in turbine blades, as the general characteristics of the metal particularly fitted in with the requirements. For the reader who is not acquainted with he characteristics of monel metal, it might be well to state that it is a naturally occurring alloy containing 67 per cent nickel, 28 per cent copper and 5 per cent of other elements. This remaining 5 per cent consists partly of iron from the the original ore and partly of manganese, silicon and carbon introduced in the process of refining. It contains no zinc or aluminum. It has a tensile strength varying from 80,000 to 90,000 lb. per sq.-in., an elongation of about 30 per cent in 2 in., and an elastic limit of from 50,000 to 60,000 lb. It is non-corrodible, tough and ductile and can be forged, soldered and welded, has the appearance of steel and takes and retains a nickel polish. It withstands the effects of high temperatures without material impairment of its strength. In connection with this it has been found that the monel-metal castings at 600 deg., as compared with the same material at 70 deg., retain 73 per cent of their elastic limit and 75 per cent of their tensile strength, while the rolled monel metal which is used in the manufacture of turbine blades retains 74 per cent of its elastic limit and 85 per cent of its tensile strength. It was calculated that the physical properties of this metal would give a factor of safety of 3 when running on test at a considerable overspeed, and a factor of safety of 4½ working under normal conditions. Subsequent tests showed these calculations to be correct. Each of the destroyers built during the war was equipped with six marine turbines, two high-pressure, two intermediate-pressure and two low-pressure, varying from 36 in. to 54 in. in diameter, revolving at 3,300 r.p.m., and developing 30,000 hp. per boat. The normal circumferential bucket speed was 42,500 ft. per min., while the test speed amounted to 53,400 ft. per min. The turbines for each destroyer contained upward of 10,000 blades, of which approximately 90 per cent were made of monel metal. Over 1,235,000 lb. of monel metal was used in the fabrication of approximately 1,500,000 turbine blades. These blades ranged from 2 in. to 9½ in. in length and were 1 in. in width. In connection with the stresses to which the turbine blades are subjected under varying speeds, there is shown in Fig. 5 a tabulation of stresses in pounds per square inch which have been worked out for one of the heaviest monel-metal blades used in the low-pressure turbines of a destroyer installation. It will be noted that the fastening of this blade to the rotor is somewhat different from the method in Fig. 8. Fig. 5 is the method used for heavy buckets; the base of the blade straddles the rim of the turbine rotor, while in Fig. 8, which is used for the small blades, the base of the turbine blade fits in grooves in the rim of the rotor. To meet the demands for rapid production with a view to the delivery of destroyer engines in as short a time as possible, it became necessary for the builders to resort to different methods of

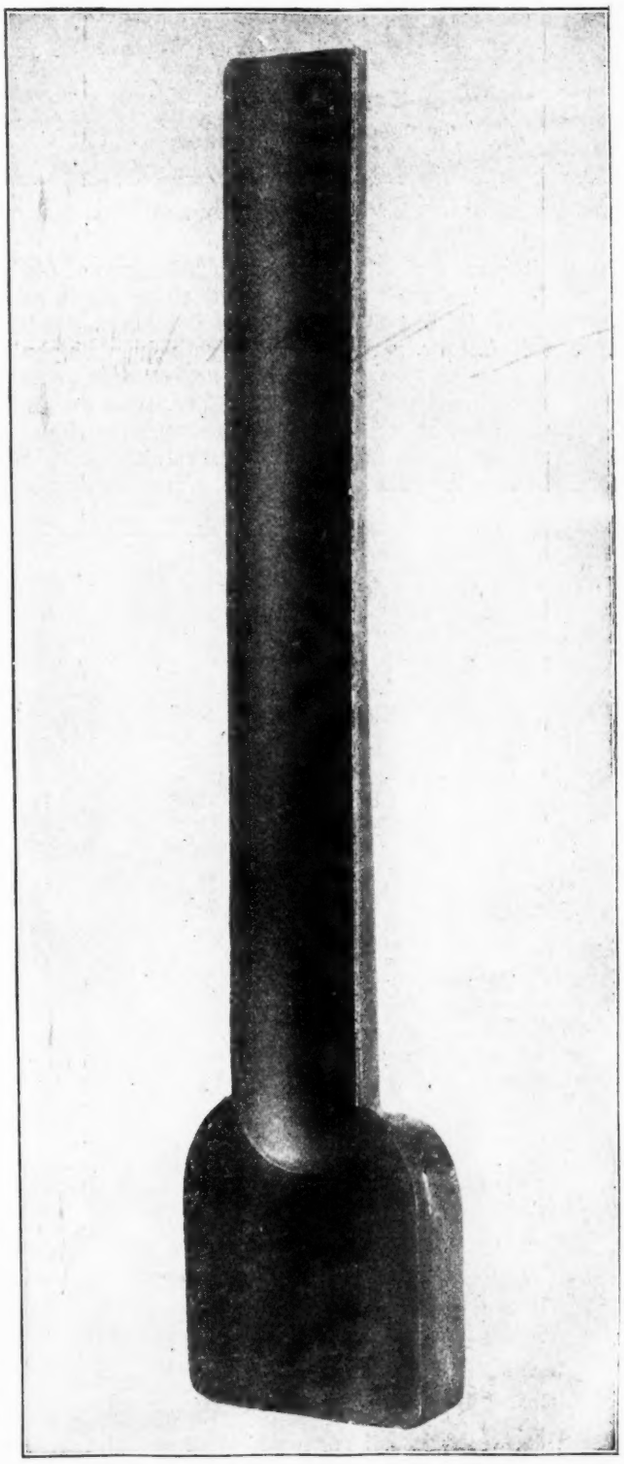


FIG. 2. THE CLEAN-CUT FORGING OF A MONEL-METAL TURBINE BLADE

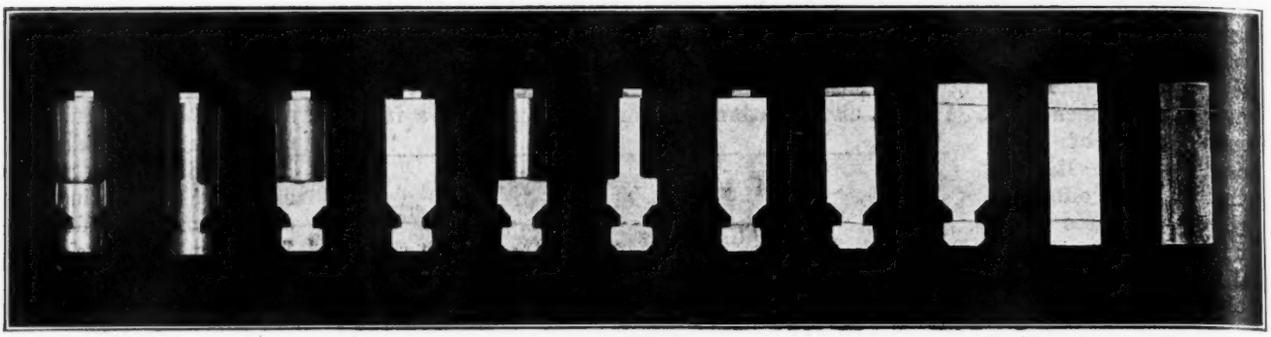


FIG. 3. BLADES IN VARIOUS STAGES OF MANUFACTURE FROM THE ROUGH MONEL BAR TO THE FINISHED BLADE

manufacture. With this in view it was decided to make the shorter blades from the bar stock and the longer blades from drop forgings, as it had been determined that the metal gave satisfactory results under the hammer.

It was found after considerable experimenting that monel metal forged as satisfactorily as steel or iron if certain precautionary measures were taken in the heating to insure the forging being made at a temperature about 1,500 deg. F. The metal forged near this temperature gave the best results. A low-sulphur fuel (oil or gas preferred) was used for heating in combination with a semi-muffle furnace, which proved to be the best type for this work. In the heating it was found that great care should be taken to insure of heating considerably beyond the portion to be forged to eliminate any abrupt lines of demarcation, which would be injurious to the physical structure of the metal.

The peculiar shape of the turbine blades and the accuracy required of these forgings rendered the work difficult from the forging standpoint, regardless of the material used. All forgings were required to be within a minus 0.004 in. and plus 0.006 in., and the allowance in variation in angles was small—only 1½ deg. The forgings made to these requirements produced blades the edges of which were about 0.02 in. in thickness, which was in accordance with the design.

Many difficulties were experienced at first in the forging of monel turbine blades, because the process was undeveloped; that is, no definite type of die had been evolved and accepted as practical for use in this work. The Remington Arms Co., the Bethlehem Steel Co., and the Fore River plant of the Bethlehem Shipbuilding Corporation finally succeeded in developing this work.

The Fore River and Bethlehem plants used roughing dies which produced an oversize forging; this forging was then reheated and brought to size under a re-striking die. The Remington Arms Co., however, finished the monel forging with one heat, which precluded the necessity of making both roughing and finishing dies, as was the custom at the Fore River and Bethlehem plants. On the other hand, the dies used in this process were not as durable. Fig. 2 shows a turbine blade forged of monel metal. Note that it is an exceptionally clean-cut forging. These forgings are generally much smoother than steel, being free from scale.

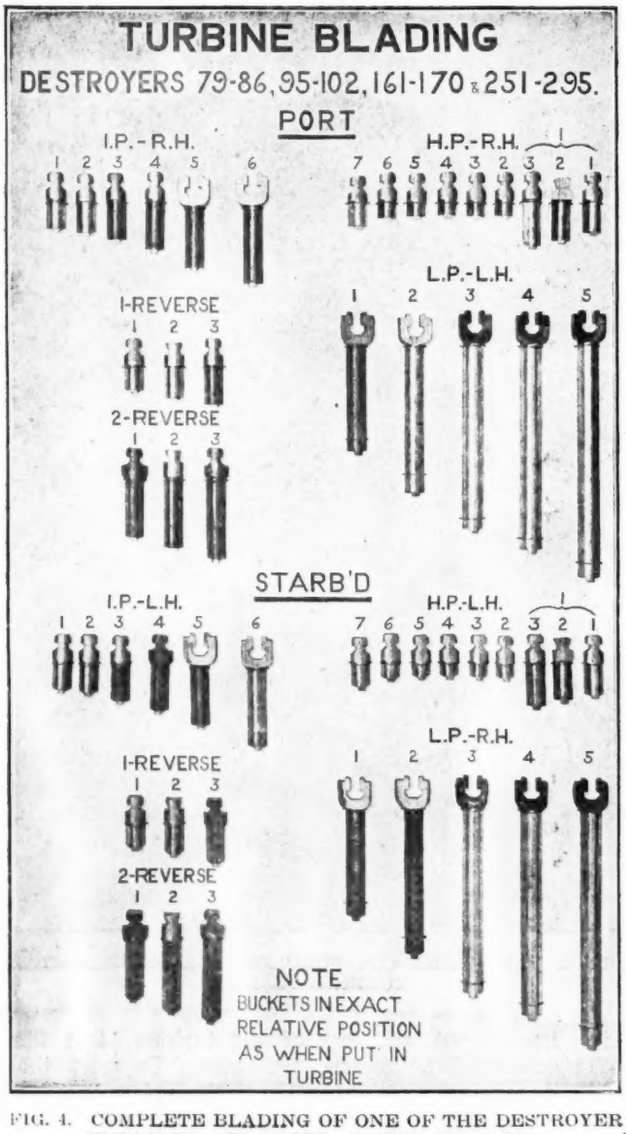


FIG. 4. COMPLETE BLADING OF ONE OF THE DESTROYER TURBINES, ARRANGED IN THE RELATIVE POSITIONS OCCUPIED IN THE TURBINE

The shorter buckets, as before mentioned, were machined from monel-metal bar stock. The Remington Arms Co., of Bridgeport, also undertook the manufacture of these blades by the machine process in addition to the drop forging of the longer blades. An elaborate system of jigs, fixtures and gages were designed for use in connection with this work. Special attention was given to the design of all cutting tools, such as milling cutters, drills, reamers, etc., with a view to particular adaptation to the cutting of the metal. It was found, however, that in most cases the standard design of cutting tools for ordinary metals answered every purpose.

For many months the Remington Arms Co. turned out machined blades of the metal at the rate of 25,000 per week. All these blades were manufactured to snap gages which allowed tolerances of only a plus and minus 0.002 in., and they were shipped to the Fore River plant

LOCATION OF STRESS	R. P. M.			
	3000	3750	4000	4200
Root Tension Sect. 1-1	11650	18200	20700	22750
" Shear " 2-2	5820	9100	10350	11380
" Compression " 3-3	16820	29400	33400	36750
Blade Tension " 4-4	11200	17500	19900	22500

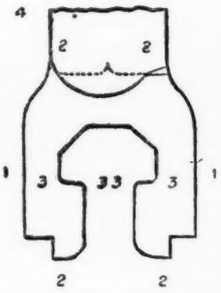


FIG. 5. TABULATION OF STRESSES WORKED OUT FOR HEAVIEST OF MONEL BLADES USED IN LOW-PRESSURE TURBINES FOR DESTROYERS

of the Bethlehem Shipbuilding Corporation, the Union plant of the Bethlehem Shipbuilding Corporation on the Pacific Coast, and to the Government turbine plant at Buffalo, where they were installed in the turbine rotors under construction.

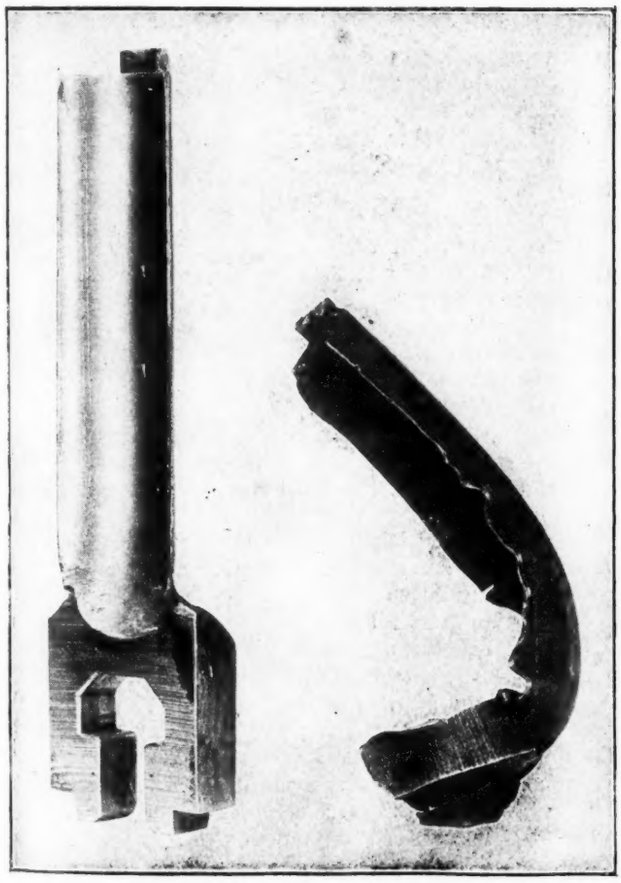


FIG. 6. NEW MONEL BLADE AND SAME BLADE AFTER BEING TORN FROM THE ROTOR BY CONTACT WITH A FRACTURED DIAPHRAGM

In connection with the manufacture of turbine blades from bar stock attention is invited to Fig. 3, which shows the blades in the different stages of manufacture from the rough bar to the completed blade. After the machining process surfaces that would later come in contact with the steam were buffed; this created a surface as smooth and bright as pure nickel.

Fig. 4 shows every size of monel blade used in the destroyer turbines. As is noted in the photograph, the

FIG. 7. MONEL BLADING AFTER TWO YEARS' SERVICE. THE EDGES ARE SHARP AND THE SURFACE SMOOTH

FIG. 8. THE BASES OF THE LARGE BLADES, AS IN FIG. 5, STRADDLE THE ROTORS, SMALL BLADES FIT IN GROOVES IN THE ROTOR

blades occupy the same relative position as when installed in turbines.

To illustrate the toughness of this material, reference is made to Fig. 6, which shows a new turbine blade, also a similar blade after it had been torn from the rotor by coming in contact with a fractured diaphragm. It can be seen that although the blade is bent more than 90 deg. it shows no fracture. This blade had been in constant use during the period of the war.

The Bethlehem Shipbuilding Corporation, having put into service during the last two years upward of 100 destroyers, all of which were fitted with monel turbine blading, have had exceptional opportunity to study this material in conjunction with steam turbines. Out of thirty turbines opened in as many destroyers, in no case was the monel blading found to be in bad condition.

Upon inspection it was found that the monel buckets that had been in service for two years were in excellent condition, showing no effects from corrosion or from the erosive effects of steam. Fig. 7 shows monel blading after two years' service. The surfaces are clean and the edges are still sharp.

It is obvious, of course, that where turbine blading retains its smoothness without corrosion, such turbines are considerably more efficient than if the blades are subject to it. This means an ultimate saving in fuel consumption. It is believed from the experience of the Bethlehem Shipbuilding Corporation that the continued efficiency of any steam turbine can be maintained only when blades are made of material that will insure the blades retaining their designed shape as originally installed, combined with the retention of smooth uncorroded surfaces. The turbines in the destroyers are the Curtis.

Although the Bethlehem Shipbuilding Corporation's chief experience with the metal is with destroyer turbines, it is using it constantly in turbines for other ships, such as cargo ships, etc.

Protective and Service-Restoring Relays

BY VICTOR H. TODD

Relays, both induction and solenoid types, for protecting circuits against undervoltage or overvoltage are discussed. Relays for ringing a bell when a circuit-breaker opens are described in detail, also a relay for protection against reverse phases. The operation of a service-restoring system, which will automatically reclose a circuit-breaker a definite number of times after it has been tripped out, is explained.

FREQUENTLY, there are conditions of abnormally high or low voltage which may lead to disastrous results if not promptly detected and corrected. Considerable damage might easily be done by an increase in voltage burning out lamps. This increase may be due to a number of causes, such as the failure of a Tirrill regulator on the generator, or a short in the generator-field resister. On the other hand, the voltage may drop to a low value. To give warning of such abnormal conditions or to actually disconnect a circuit should conditions so determine, an overvoltage or an undervoltage relay may be installed. Such a relay is shown in Fig. 1 and is the same in construction and

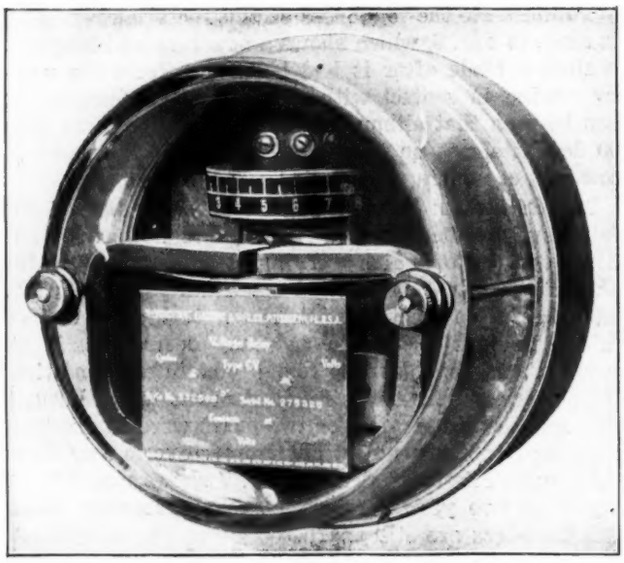


FIG. 1. OVERVOLTAGE OR UNDERVOLTAGE RELAY

principle of operation as the induction-type overload relay, except that the windings are wound to stand the impressed voltage. In the overvoltage relays the contacts close when the voltage exceeds a certain predetermined point, which trips a breaker, rings a gong or gives other signals to the operator that the voltage is too high and requires attention. By means of a little lever on the relay the tripping voltage may be varied over wide ranges, generally between 75 per cent and 160 per cent of normal. Therefore, if a circuit is normally operating at 110 volts, it becomes possible to trip it or ring a bell if it goes to 115 or 120 volts or higher. In the undervoltage relay the windings are arranged so that the voltage tends to keep the contacts open. Then, should the voltage drop to 75 or 80 per cent of normal or for whatever the relay is set, there is no longer torque enough to hold the contacts open, so they close and generally sound an alarm.

The solenoid principle, as well as the induction principle, may be used to indicate the conditions of overvoltage and undervoltage, but the adjustment of the solenoid type is not as refined as that of the induction type. In the solenoid type the plunger is arranged to move upward and close contacts on overvoltage. For undervoltage the solenoid normally holds the plunger up and contacts open, but on a decrease in voltage, the plunger drops and the contacts close. A solenoid relay of the latter type is shown in Fig. 2. In such circuits as the constant-current systems conditions are such that an indication of low current is required. To provide this, a regular induction-type relay is used, excepting that the current tends to keep the contacts open. Then, if the current drops to a certain predetermined value, there will no longer be sufficient torque to hold the contacts open, and thus they close and give a signal or trip a breaker. If a circuit-breaker is tripped out, and the station attendant, instead of being near at hand where he can see and reset it, is some distance away, a bell-ringing relay may be used. This must ring the bell or alarm until some notice or action is taken if the breaker opens due to the protective relays tripping, but it is not necessary to ring the bell if the breaker has been opened intentionally. The relay, Fig. 3, with the cover removed will meet the foregoing requirements. A schematic connection diagram is given in Fig. 4, and the operation is as follows:

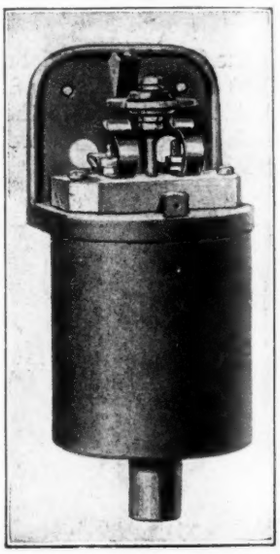


FIG. 2. SOLENOID-TYPE UNDERVOLTAGE RELAY

The two electromagnets *A* and *B* are arranged to attract the iron armature *C*, pivoted at *D*, which closes contacts *E* and *F* when attracted. The solenoid *A* is placed in series with the trip coil and relay contacts of the breaker, so that when the relay closes it energizes solenoid *A*. This attracts armature *C* and closes both contacts *E* and *F*. Contact *E* closes the circuit to solenoid *B* through a resistance *G*, and contact *F* closes the circuit to a bell or alarm *H*. Now, even though the circuit to *A* is opened, as it would be if the breaker opened, solenoid *B* still holds the contacts closed and the bell will continue to ring until the switch *I* is opened for an instant, which allows the armature to drop and the contacts to open. These relays can be used when a direct-current circuit is available for tripping the breaker. It will also be seen that should the breaker be tripped by hand, the relay

cannot operate, consequently the bell rings only on automatic tripping. If, for any reason, one of the phases of the circuit supplying a polyphase motor is reversed, it will run backward. Such a reversal may occur when the motor is disconnected for repairs, through an error in reconnecting leads at the power house or substation, or from a number of other causes. In many cases the reversal of rotation of a motor, aside from

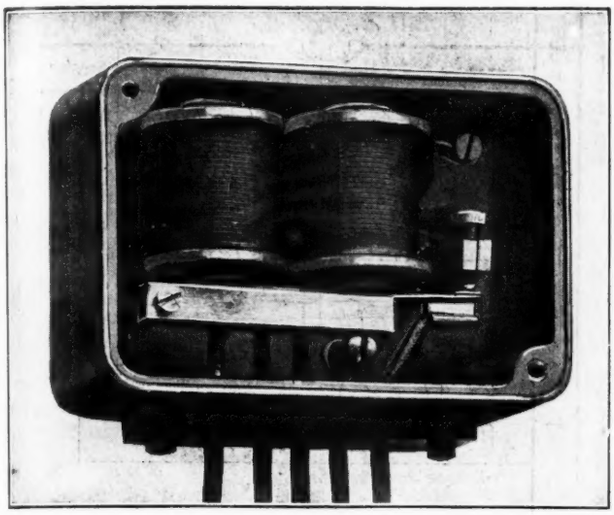


FIG. 3. CIRCUIT-BREAKER BELL-RINGING RELAY

the inconvenience that it causes, is not a serious matter, as the error can readily be corrected at the motor terminals.

In other cases, however, serious consequences may result. The reversal of an elevator motor, for instance, might result in wrecking the machinery or loss of life. To protect motors against phase reversal, the reverse-phase relay has been developed, one type of which is shown in Fig. 5. The parts are all identical with the overload induction-type relay with the exception of windings. The main coil is a voltage coil exactly like a watt-hour meter, but the series coil, instead of being heavy wire, is a large number of turns of fine wire connected in series with a reactor which gives its current similar lagging characteristics to the other potential coil.

Inasmuch as one coil is tapped on one phase and one on the other, they have the necessary phase displacement to produce a shifting field, which reacts on the disc. The external connections are shown in Fig. 6. Normally, the voltage tends to rotate the disc to the right and keep the contacts open, but should one phase be reversed or fail, or the voltage drop below 75 per cent of normal, then the contacts close and open a breaker. Reversal of a phase reverses the direction of rotation, causing the contacts to close very quickly.

There are many cases in which it is only necessary to open the breaker to clear a short; for instance, an arc across two lines, which is killed the instant the breaker opens. This permits the feeders to be put back in service immediately. If the circuit-breaker is reclosed automatically within a second after the transient trouble has occurred, the service will be restored in time to prevent induction motors from stalling.

The service-restoring relay system has been developed to perform this operation within the shortest possible time and thus reduce all disturbances to a minimum, thereby greatly improving the service. Should a permanent defect occur, the system will allow the breaker to remain open until the defect is cleared.

A schematic diagram of a service-restoring relay system is shown in Fig. 7. Any type of overload relay may be employed to trip the circuit-breaker on overload as previously described. A voltage transformer on the feeder outside the circuit-breaker is connected so that its potential opposes that of another voltage trans-

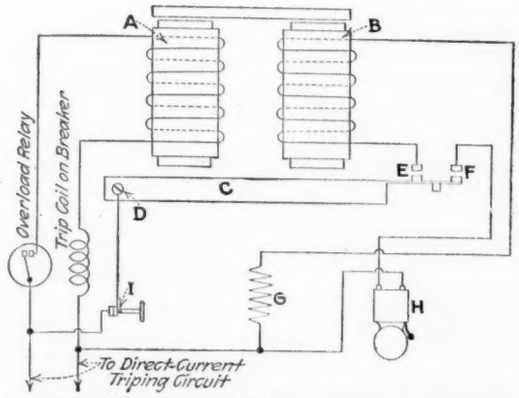


FIG. 4. SCHEMATIC DIAGRAM OF CONNECTION FOR BELL-RINGING RELAY, FIG. 3

former connected to the busbars. The restoring relay, which is similar to a magnet switch, is connected in series with these two voltage transformers. Before a short-circuit occurs, both voltage transformers are subjected to the same condition so that no current will flow through the restoring relay; but when a short-circuit occurs and the circuit-breaker has been opened

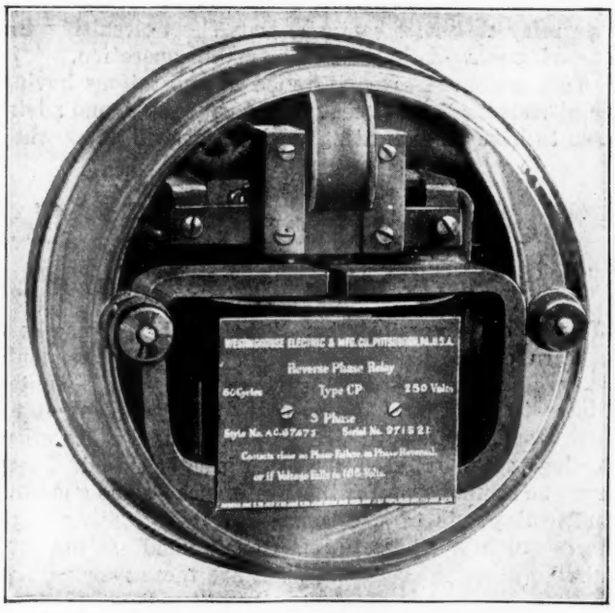


FIG. 5. REVERSE-PHASE RELAY

by the overload relay, current will be supplied by the busbar transformer *B* into the feeder transformer *A* through the restoring relay. The restoring relay will then close its contacts, which in turn will close the circuit-breaker. The latter, of course, must be of the electrically closing type as well as electrically tripping.

In case of a permanent defect on the feeder the restoring relay would continue to open and close the circuit-breaker indefinitely, since each time the breaker

closed, the overload relay would open it. To prevent this, a limiting relay, similar to the overvoltage relay but equipped with weaker springs and heavier damping magnets so that its action is sluggish, is connected in such a manner that while the circuit-breaker is open it is subject to the same difference of potential that is operating the restoring relay. Every time the circuit-breaker opens, the limiting relay contacts begin to close, and owing to its heavy damping, they do not return to the starting point immediately after the circuit-breaker is closed. After the circuit-breaker has opened and closed a predetermined number of times, this relay closes its contacts, thus short-circuiting the restoring relay and preventing further operation.

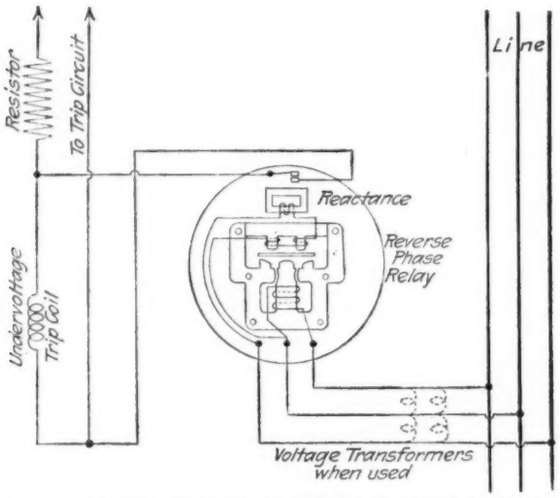


FIG. 6. SCHEMATIC DIAGRAM OF CONNECTION FOR REVERSE-PHASE RELAY

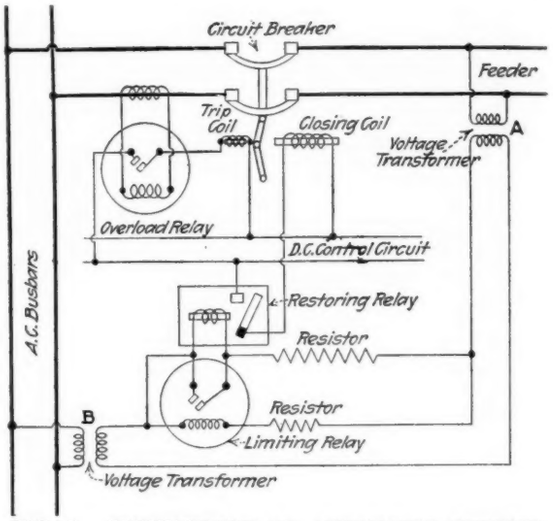


FIG. 7. CONNECTIONS OF AUTOMATIC SERVICE-RESTORING SYSTEM

This system is often installed at substations having no attendant. In that case it is frequently found advisable to have an indicating device that will show when the service has been momentarily interrupted. For this purpose a graphic ammeter is placed in the direct-current control circuit of the circuit-breaker. This will indicate whenever the breaker has been closed by automatic means. When this system is used and provision is made for manually tripping the breaker by a control switch, contacts are arranged on the control switch which automatically open the circuit between the two voltage transformers, which prevents the breaker from resetting immediately after it is tripped.

With this device only 0.7 of a second is required from the first instant of overload to the instant of resumed service. If, however, the short-circuit is not removed upon the opening of the breaker, then when the breaker recloses, the short-circuit current immediately operates the overhead relay and again trips the breaker until the limiting relay prevents further action.

Refrigeration Study Course — XI. Refrigerants

By H. J. MACINTIRE

IT IS quite possible that there has been some concern on the part of engineers as to why ammonia machines are used for refrigeration in the United States to the extent of more than 95 per cent of all such work, whereas in Great Britain and France other cooling vapors are used to a much greater extent. There must be some reason for this preference—some good and sufficient points of excellence—for refrigerating engineers are in business to make money and are not conducting a health crusade. What are these reasons, and why do not sulphur dioxide, carbon dioxide, ethyl chloride and other vapors gain in popularity?

All engineering questions have two sides, and few if any live matters can be answered definitely and decidedly one way or the other. As an example, there is the question of the use of the jet or the surface condenser for stationary plants (there is no question as regards surface condensers in marine work). There is the question of star or delta windings in electric machinery or of two-phase or three-phase transmission, and the question of steam engine or turbine as compared with the Diesel oil engine, and both of these as compared with the development of water power. The questions of load factor, cost of fuel, cost of money (if borrowed), kind and quantity of water, proximity and quality of feul to be used, etc., are factors that must be weighed in the balance or balance sheet. No cut and dried answer will avail for all cases, but each individual case must be decided for itself.

Possible Refrigerants

The refrigerating engineer understands that our object with the use of the compressor and the high pressure side is to be able to use the same refrigerant continuously. We compress the gas boiling off from the refrigerating coils in order that condensation of the gas may be possible at temperatures of 60, 70 or 80 degrees or even higher, depending on what temperature of cooling or condenser water may be obtained. The gas compressed passes through the compressor, and the amount of gas so compressed per interval of time depends on the piston displacement of the compressor. Naturally, we are interested not only in the pressure range of the compressor (the suction and discharge

pressures required by the refrigerant used), but also in the cooling effect obtainable by one cubic foot of compressor displacement.

There are in addition the factors of the cost of the substance used, the pathological effect should the stuff escape from the compressor or cold-storage piping and the chemical effect on iron, steel and brass. Of these the first item, the cost of the refrigerant, is too great in every case to allow the substance to be thrown away. If air were used, it might be possible to exhaust it into the atmosphere after using, but air is no longer employed. The effect on human life of the gas used is different with each substance. Carbon dioxide is harmless in small quantities and is odorless when pure. In large quantities its effect on one is practically the same as being submerged in water. Sulphur dioxide and ammonia are deadly in small quantities if relief is not immediately obtained. Ethyl chloride in small quantities seems to be the least harmful of all present refrigerants, and for that reason it is used to a large extent on naval vessels. The result in all cases is that careful provision has to be made for preventing leaks or breaks in the pipes or headers. Also, it is necessary to provide for withdrawing the charge into drums or for storage in another part of the system when repairs or cleaning of any portion of the plant has to be performed.

The main difference in refrigerants, and (with the exception of ethyl chloride for use on shipboard) the deciding factor in its choice, lies in the physical properties as regards the pressures usually obtained during operation, the refrigerating effect of one pound of the

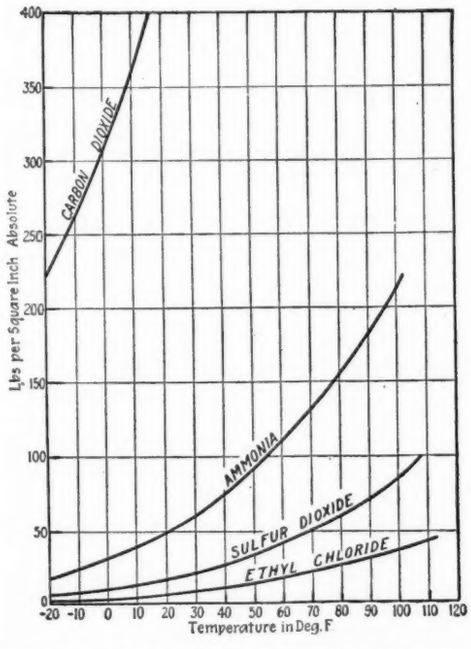


FIG. 1. CURVES SHOWING PRESSURES OF COMMON REFRIGERANTS AT COMMON TEMPERATURES

substance, and finally the volume of one pound of the refrigerant at the pressure of boiling in the expansion coils.

Referring to Fig. 1, it will be seen that ethyl chloride has the least and sulphur dioxide very moderate pressures corresponding to the temperatures of the cooling coils or the condenser, but carbon dioxide has extremely heavy pressures—some 200 to 300 lb. for suction and 800 to 1,000 lb. per sq. in. for the condenser pressure. These latter pressures are so great as to require special materials both for the compression and piping, and this factor is one that has been a deciding point in all save a few particular cases in the United States. As will be seen, the size of compressor using carbon dioxide and the fact that the gas is not necessarily dangerous immediately has caused it to be used in many places where space is valuable and where congestion makes it doubly dangerous to use ammonia. Fig. 1 also shows that ammonia has moderate pressures, both at zero degrees F. (for the cooling coils) and at 70 to 80 deg. F. (for the condensing piping). The pressures encountered are nominal and are those which steam engineers are used to. The substance, however, has greater ability for escaping out of confinement than has steam or air, and also it has a corroding action on copper and brass, and therefore the materials used are special air-furnace cast iron of extra thickness, steel forged fittings or high-grade semi-steel castings, and either extra-heavy steel or wrought-iron pipe. The joints have to be special, either screwed fittings using litharge and glycerin or solder joints or flanged joints using tongue and groove with lead or rubber gaskets.

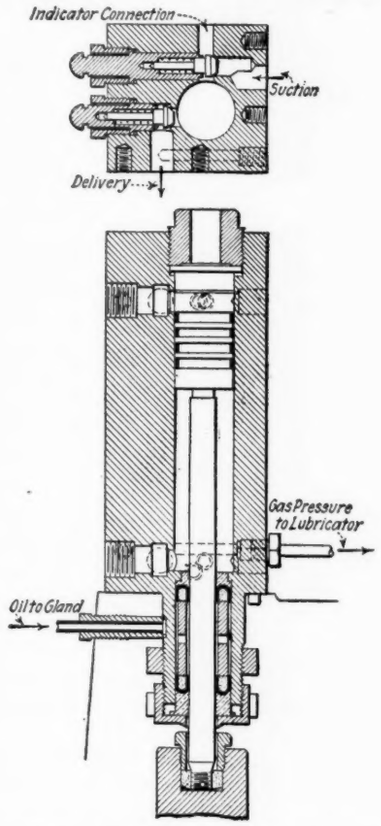


FIG. 2. SECTION OF A TYPICAL CARBON-DIOXIDE COMPRESSOR CYLINDER

However, in the final analysis the real points to be considered are the horsepower input per ton of refrigeration and the cubic feet of piston displacement of the compressor per ton. All other factors fade in comparison unless the conditions are ultra-extreme. Of course we desire to produce refrigeration at as small cost of power as we can, and this cost of power is mostly in the demands of the compressor. The compressor pumps the gas from the refrigerating coils to the condenser, and the condenser pressure is determined by the temperature and the amount of cooling water used. Again, as a rule, the *volume* of gas handled affects not only the size and cost of the compressor, but of the high- and low-pressure sides as well.

Volume Displaced by Compressor

Referring to the table, it will be seen that the volume displaced by the compressor is less for CO_2 (carbon dioxide) than for any other of the refrigerants. In fact, ammonia is 4.6, sulphur dioxide 12.4 and ethyl

chloride is 39.3 times as great as carbon dioxide for similar conditions. For the same piston speed the areas of the respective cylinders would have to have these same values, and the diameters would have to be 2.15, 3.5 and 6.27 times as great as for carbon dioxide. Ethyl chloride is fortunate on account of the small number of operating troubles. The low side, being subject only to an inward pressure, will leak air into the system if

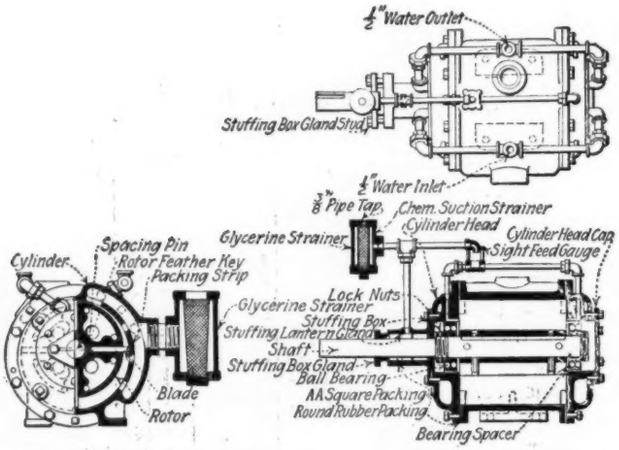


FIG. 3. ROTARY COMPRESSOR AS APPLIED TO USE OF ETHYL CHLORIDE

leaks should occur, but leaks are readily prevented with proper designs and careful operation. When air does accumulate, it collects in the condenser, from which it can be purged in the usual manner. The gas, however, is not entirely harmless and, if taken in large enough quantities, will put one to sleep like any anesthesia, and with about twice its volume of air forms an explosive mixture. The vapor burns readily with a greenish-edged flame. On account of its extremely great volume at usual refrigerating temperatures, its applications have been limited to special cases and at present to rather small machines. Being of very low condenser pressures, it lends itself to the use of the blower, or centrifugal compressor, to great advantage. The centrifugal compressor (for ethyl chloride or other refrigerants) certainly is going to be used to a greater extent in the future, especially as direct connection to steam turbines and the cheaper (higher speeds) electric motors are possible with reduced losses.

Sulphur dioxide has nominal pressures and, like carbon dioxide, does not have a bad effect on copper or brass. Sulphur dioxide is self-lubricating, whereas ethyl chloride and carbon dioxide require glycerin for that purpose. The great objection to sulphur dioxide is the corroding action on iron and steel wherever moisture gets into the system. The combination of water and sulphur dioxide forms sulphurous acid. The result is that the sulphur-dioxide machine has to be very self-contained and sealed against air leakage. In this country these machines are used only in the smaller sizes and are seldom, if ever, used where direct expansion is employed in the sense that is usually understood. To do so not only would require large return mains, but would greatly increase the possibilities of corrosion.

Carbon dioxide has its particular field in congested localities, such as office buildings, hotels and marine installations. An escape into the air of a charge of carbon dioxide is not so disagreeable and subject to unfavorable notice as is ammonia. Being much heavier than air, it will not rise except by diffusion, and guests or tenants are not driven out of their rooms. Also, unlike ammonia and ethyl chloride, it is not a combustible nor will it form explosive mixtures with air as the other two will. But, on the other hand, it is preferably a cold cooling-water refrigerant. Its critical temperature is 88.4 deg. F., which means that in extreme cases in the tropics or for machine work in certain locations, it is possible that the discharge gas passing into the condenser will not be condensed, but will act somewhat like the "dense-air" refrigerating machine. Under such conditions its efficiency is badly reduced, and much better results could have been obtained by the use of some other refrigerant.

Power Used Per Ton of Refrigeration

It so happens that, contrary to the expectation of most engineers, the power required by the different refrigerating machines per unit of refrigeration is about equal. One could expect that carbon dioxide, working as it does with a pressure range of about 550 lb., would require more power input than would, say, sulphur dioxide, which works between the limits of minus 5 lb. and 35 lb. or only 40 lb. total pressure. However, the volumes to be pumped are to be considered, and there are 12.4 times as much sulphur dioxide as carbon dioxide to be pumped for equal refrigerating effect. The net result is that carbon dioxide requires a little more power than does ammonia or sulphur dioxide. In fact, ammonia leads slightly in this respect, but the net result is so close that the matter of the horsepower per ton of refrigeration for usual (standard) operating conditions need not be considered when deciding on one or the other refrigerant.

TABLE I. SOME PROPERTIES OF REFRIGERANTS

	Latent Heat at 0 Deg. F., B.t.u.	Net Refrigeration Effect at 0 Deg. F.	Volume gas Pumped per 100,000 B.t.u. Refrigeration, Cu.Ft.	Column 3 with Carbon Dioxide as Unity	Approximate Condenser Pressure, Lb.	Approximate Suction Pressure, Lb.
Sulphur dioxide	171.8	148.7	4,970	12.4	35.0	— 5.0
Ammonia	572.2	496.4	1,848	4.61	114.5	15.25
Carbon dioxide	117.0	73.1	401	1.0	834.0	291.0
Ethyl chloride	149.4	119.4	15,720	39.3	5.5	—10.6

All pressures are gage.

Finally, it may be said that ammonia is preferred in this country because of its nominal pressures for a large range of work using condensing water varying from 50 to 80 or even 90 deg. F. and suction pressures from minus 5 lb. to 20 or 30 lb. gage. Its specific volumes are also nominal, thereby allowing moderate-sized suction return lines and headers. The piston displacement required is convenient, and so the cost of the compressor and the space occupied are small. The American engineer feels more at home with such conditions, and so amomnia holds its popularity.

The peat bogs of Manitoba, Ontario, Quebec, and New Brunswick cover an area of 12,000 square miles, with an average depth of 6 ft., and are estimated by the Commission of Conservation to contain some 9,300,000,000 tons of peat. Seven bogs within convenient delivery of Toronto are estimated to be capable of producing 26,500,000 tons of fuel, and seven bogs in the vicinity of Montreal could supply that city with 23,500,000 tons.

High Wages Influence Power-Plant Design

Complications in Conversion of Three Thousand-Kilowatt Station Into One of Eight Thousand-Kilowatt Capacity

THE important influence of the rate of wages upon boiler-plant design is strikingly shown in connection with the enlargement of the Charlotte Street power plant of the Charleston (S. C.) Consolidated Railway and Lighting Co., recently completed. When this station was originally built in 1912, colored firemen could be hired a-plenty for a dollar a day, and therefore the need for labor-saving stokers was not felt to anything like the degree that it is today. Nor was the better efficiency of stokers so potent a factor, for the price of coal was also low. Consequently, the boiler plant for the original station was laid out for hand firing.

But when the war brought on the necessity for a large expansion of the power-plant capacity, colored firemen could be secured only with difficulty at $4.50 a day. In the face of this there could be no argument as to whether stokers should be employed with the new boilers needed to increase the station capacity from 3,000 to 8,000 kw., and this was easily justifiable even though it involved many complications in working a modern stoker-fired battery into the old layout, the plan of enlargement being to retain the hand-fired boilers until a later date. How some of these difficulties of design were worked out is brought out in what follows.

Prior to reconstruction the Charlotte Street Station was laid out with a long boiler room parallel to the turbine room, the boilers being set in a single row and backed up against the turbine-room wall, with the

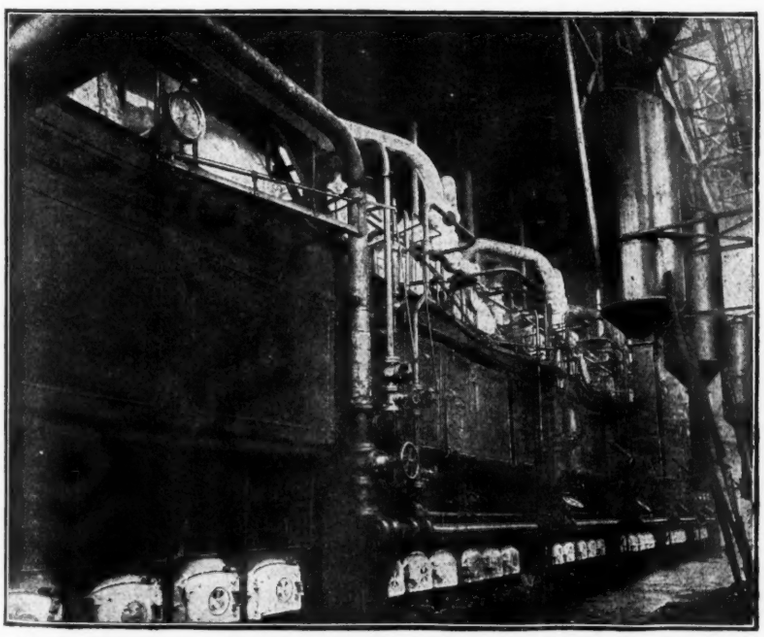


FIG. 1. FIRING AISLE IN THE NEW ADDITION AND COAL BUNKERS FOR THE HAND-FIRED BOILERS

firing aisle along the outside building wall. The equipment of the boiler room comprised one 518-hp. and five 528-hp. water-tube boilers, all hand-fired. They were installed on a floor level several feet below that of the turbine room and supplied steam at 160 lb. pressure to two 2,000-kw. and one 1,000-kw. 2,300-volt three-phase turbo-generator sets equipped with jet condensers. The turbine room was originally designed for an

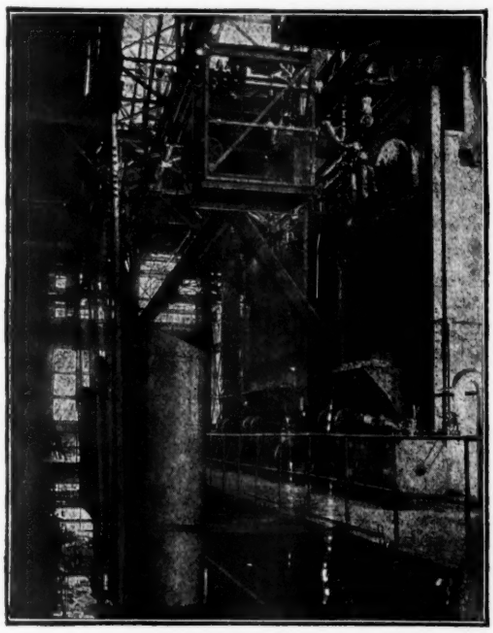


FIG. 2. HAND-FIRED BOILERS AND TEMPORARY COAL BUNKERS

ultimate installation of four 2,000-kw. units, so that there was ample space in which to place additional machines at the time enlargement became necessary in 1918. The pressing demand for a large increase in output, due to Government operations and to an unprecedented growth of the city, however, made it advisable to install a 5,000-kw. unit instead of an additional 2,000-kw. machine as originally planned. The resulting installation of a 5,000-kw. 13,200-volt three-phase unit, operating at 200-lb. steam pressure and equipped with a surface condenser, did not involve any particular difficulties so far as the turbine-room construction was concerned. The real problem lay in the boiler plant.

In the boiler room it was necessary to install three new 509-hp. boilers equipped with underfeed stokers, generating steam at 220 lb. pressure and 125 deg. superheat to serve the new turbine. This necessitated a considerable enlargement and rearrangement of the boiler house.

The side and part of the end wall of the boiler room were knocked out and the building extended sufficiently to provide space for the new boilers on the opposite side of the old firing aisle. Taking out the old wall

necessitated some special construction in order to support the old roof trusses, which were cut off to make way for the new skylight and roof construction. This was done by supporting these shortened existing trusses by a cantilever construction from the roof trusses of the new extension, which were at a considerably higher elevation. The arrangement may be seen in the accompanying cross-sectional drawing of the boiler- room addition.

The present boiler-room extension was made large enough for the three new boilers and one more. Later, by removing a temporary wall and extending the building longitudinally, two more boilers of the same size can be installed. When the capacity of this battery of six is exceeded, the hand-fired boilers on the opposite side of the aisle will be replaced with six of the stoker-fired type, giving an ultimate total capacity in twelve boilers of 6,108 horse power. Using underfeed stokers made it necessary to raise the operating floor for the new boilers to a height 18 ft. above the old boiler-room floor. This meant that in combining the old and new boiler equipment into a single plant, there must be two operating floor levels. However, the new boilers and equipment for them were so installed as to be in proper location for the ultimate arrangement of stoker-fired boilers on both sides of the firing aisle, doing away with the lower operating floor. For the new boilers it was necessary to build a new brick stack and to install a new coal- and ash-handling system. The steel smoke flue connecting the uptakes from the three new boilers was mounted on top of the boiler house and connected to the chimney at a point some sixty feet above the ground, as seen in an accompanying picture. The uptakes were carried up nearly vertically within the building to connect to this overhead flue. This arrangement gives ample space for the future installation of economizers if they are desired. On the same consideration that determined the use of hand-fired boilers in the original plant, coal was handled into the firing aisle, and ashes out, by wheelbarrow. Likewise, the same consideration that determined the installation of stokers in the new boiler plant dictated the installation of a modern labor saving coal-handling plant.

Coal delivered in side- or bottom-dump cars is unloaded into a pit beside the boiler house. From here it passes through a crusher installed underneath the pit, discharging into a bucket conveyor. This, in turn, elevates the coal up to the top of the building and across over the roof, discharging into an overhead concrete bunker of 350-ton capacity. The size of this overhead bunker was made large enough to meet the requirements of the ultimate boiler plant for three days' supply. The continuous bucket conveyor may be seen in Fig. 3, the accompanying exterior view of the station, located between the stack and the building. From the overhead bunker coal is discharged by gravity into a weighing lorry, mounted on a runway over the center of the firing aisle. Then a spout from the lorry discharges the coal into the stokers of the new boilers. An ingenious scheme was worked out, with the installation of the coal-handling equipment, to make it serve the hand-fired boilers also and thereby do away entirely with the wheelbarrow method of bringing coal into the plant. In addition to serving the stokers the lorry spout also discharges coal into three vertical cylindrical steel bunkers, each serving two of the hand-fired boilers. These bunkers were suspended from above on one side, supported by steel bracing from the lower operating floor on the opposite side and braced laterally by angle irons bolted to the upper concrete floor. From the bottom of each of these bunkers a vertical spout extends downward to the lower operating floor, and through a gate at the end of the spout the coal is discharged in front of the boilers. From here it is shoveled into the boilers by hand in the usual manner.

For reserve coal supply an area adjacent to the track pit provides a storage capacity sufficient to operate the plant for seventy to

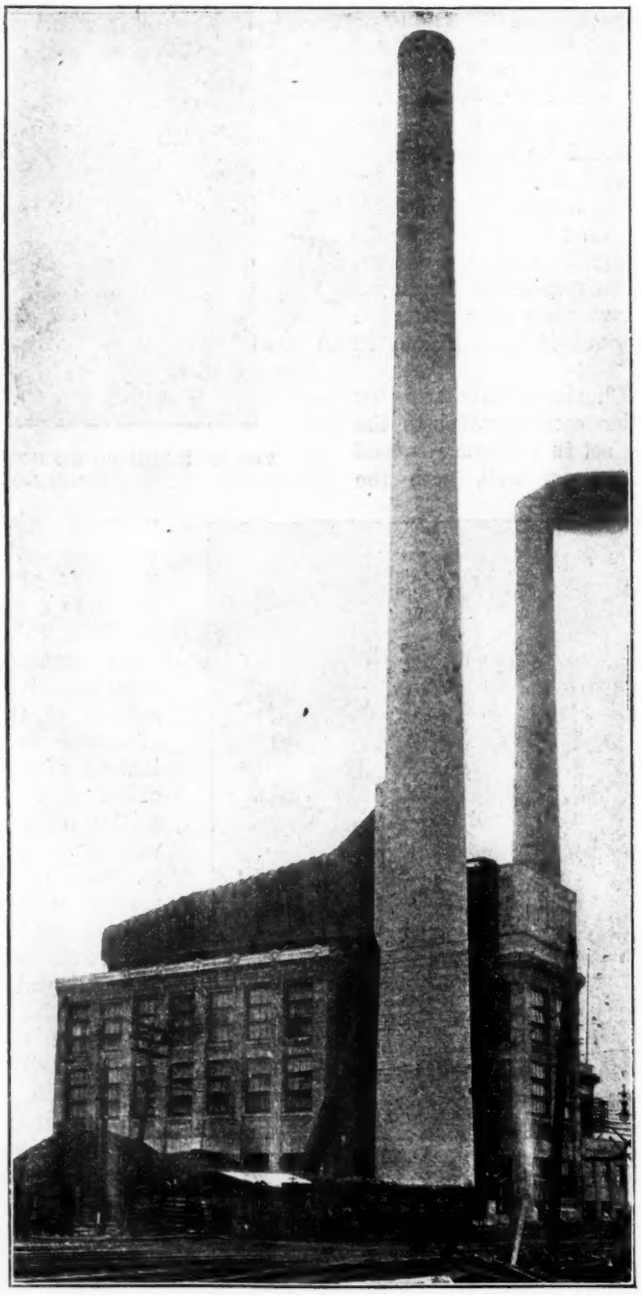


FIG. 3. VIEW OF STATION FROM THE BOILER-ROOM SIDE

eighty days. The coal is unloaded from cars and delivered to the storage pile by means of a locomotive crane equipped with a one-ton bucket. This crane is used also to shift cars. When operating normally, all the storage coal needed is within reach of this crane, so that it may be picked up from storage and dumped directly into the track pit which supplies the crusher.

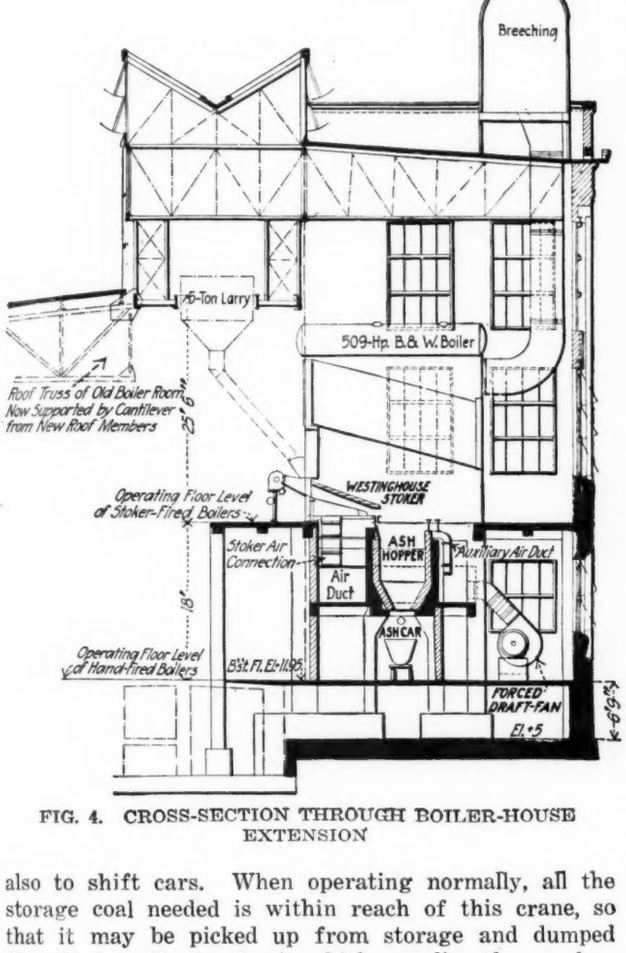


FIG. 4. CROSS-SECTION THROUGH BOILER-HOUSE EXTENSION

From the stokers the ashes are dumped into quenching hoppers and discharged into small cars underneath, running on a track at the ground level. Ashes from the hand-fired boilers are raked into the firing aisle and taken out in wheelbarrows as was done in the original plant.

In connection with the supply of circulating water for the condensers, two new turbine-driven pumps were installed, each having a capacity of 500 gal. per min. and large enough to handle the supply for the entire station. Water is taken from the Cooper River, on which the station is located, by means of a long siphon which dips down into a concrete pit at the river end and discharges into a tunnel under the power house. The condenser circulating pumps for the older units draw water from this tunnel, a 36-in. pipe being used for the siphon lead into the tunnel. With the installation of the new 5,000-kw. unit, a new 48-in. pipe was used to siphon the water to a separate tunnel. While this pipe is large enough to take care of the total requirements of the plant, the connections of the three jet condensers on the smaller turbines to the older tunnel were continued and no connection made with the larger supply in order to keep down the present cost of the installation. The condenser water supply as well as the steam supply for the new unit is therefore entirely separate from that for the older machines in the plant.

An interesting scheme was worked out in connection with the old siphon pipe in order to increase the capacity. When all three of the older units were running, the siphon would not deliver water fast enough to meet the requirements, the tunnel from which the condensers draw being open to the atmosphere at the time this scheme was adopted. To increase the capacity, the tunnel was sealed off and a steam exhauster put on it to create a vacuum of about 5 in. This increased the flow of water to such an extent that the supply was ample for the full requirements of the three units which it served.

The complete inlependence of the old and new portions of the plant was maintained, so that the future substitution of mechanically operated boilers for the present hand-fired ones would interfere as little as possible with the operation of the station.

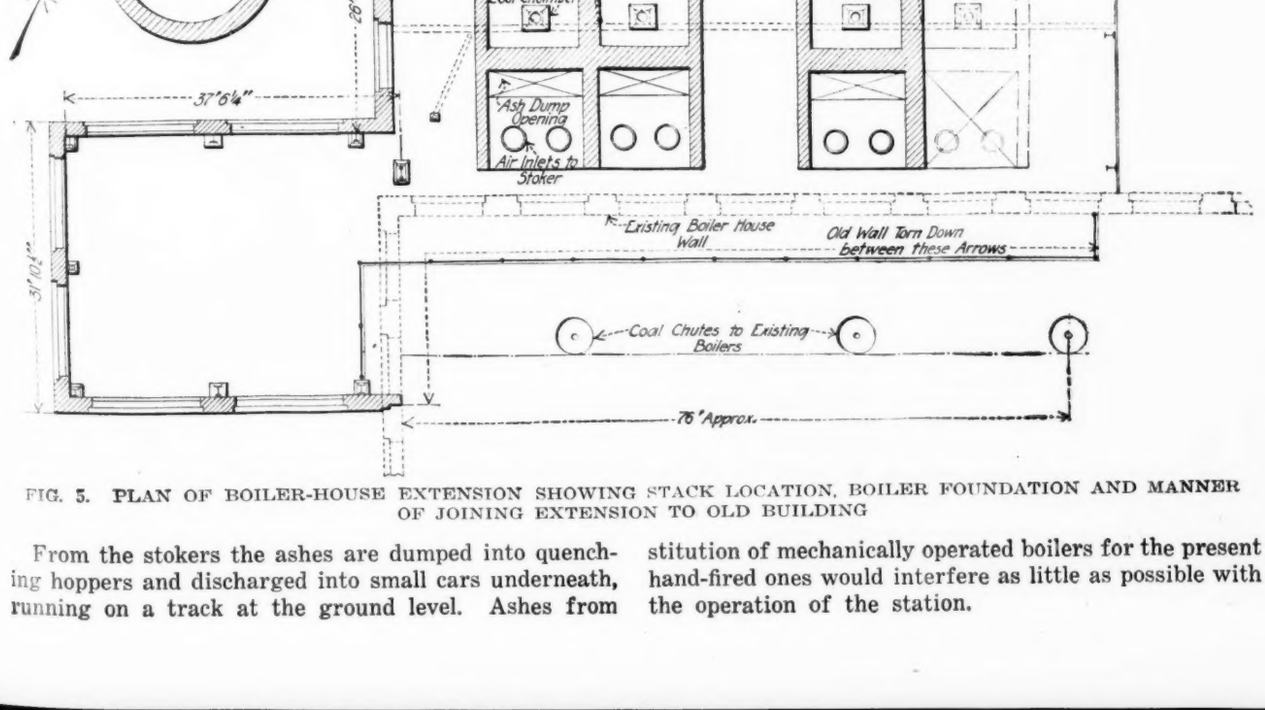


FIG. 5. PLAN OF BOILER-HOUSE EXTENSION SHOWING STACK LOCATION, BOILER FOUNDATION AND MANNER OF JOINING EXTENSION TO OLD BUILDING

Electric Elevator Machinery—Motor Operation

By M. A. MYERS
Electrical Engineer, The Maintenance Company, New York City

This article is the first of a series on electric elevator machinery and briefly outlines the essential parts of a modern elevator machine and their functions, after which the types of motors used on elevator machines are discussed. The next article to follow will treat of the care, maintenance and adjustment of elevator brakes. There is no more important part of the elevator machine than the brake, yet very little has been written about it up to this time. Power is, therefore, very fortunate to be able to present Mr. Myers' admirable treatise on the subject of elevator brakes to its readers.—EDITOR.

ELECTRIC elevators may be of the drum type, with cables winding and unwinding on a spirally scored drum, Fig. 1, or of the traction type, with continuous cables between car and counterweights, and depending upon the frictional grip between cables and suitably grooved sheaves for traction, Fig. 2. They may be full magnetically controlled with a car switch, magnetically operated reversing switches, brake and accessories; or they may be mechanically operated with a hand rope, mechanically operated reversing switch and brake; or any combination of the two methods may be used, such as hand rope and mechanically operated reversing switch, electric main switch, and electric brake. In Fig. 3 is shown a Wheeler-McDowell Elevator Co.'s drum-type elevator machine arranged for mechanical control and electrically operated brake.

By considering an ordinary full magnetic car-switch, drum-type elevator, a comprehensive idea of electric elevators in general may be obtained, after which other types, all of which have similar operating characteristics, may be discussed and easily understood. Starting with the machinery on the bedplate, which may be assumed to be located in the basement, the essential parts are: Motor, controller, coupling, brake, worm reduction gear, thrust bearings, winding drum, automatic machine limits (stops), slack-cable device, car- and drum-counterweight cables, vibrating sheave for counterweight cables, overhead sheaves, car and counterweight guide rails, car guide shoes, car safety plank and accessories, car counterweight cables, drum and car counterweights and safety overspeed governor. The motor must be capable of starting in either direction without sparking under heavy loads. Modern practice to a large degree is employing the commutating-pole type of direct-current motor, on account of its fixed neutral point and sparkless commutation under wide variations of load. The commutating-pole motor is admirably adapted for the two-speed elevator, since a wide range of speed can be obtained by means of shunt-field regulation. In actual practice this range is from about 400 to 500 r.p.m. for the slow speed to about 800 r.p.m. for the high. A compound winding on the motor is also desirable in order that the inrush at starting, which is usually 50 per cent greater than the full-load current, may be utilized to build up the field strength rapidly. This aids in giving the motor a high starting torque and a smooth start, at the same time reacting to hold the starting current to a minimum value. Plain shunt motors in elevator service have been known to "overshoot" their normal speed, by reason of the comparative slowness with which their field strength built up from shunt excitation only and also because of the effects of armature reaction.

Provisions must be made in the control to short-circuit the series winding in the motor after acceleration is completed. With the car loaded on the down motion above a certain value, the motor is converted into a generator; under this condition current flows through the series coils in opposition to that in the shunt coils, weakening the field strength sufficiently to overspeed the motor. This overspeeding may be enough to set the car safety. However, there are cases known where the car, being too near the bottom landing for the safety shoes to properly take hold and the speed being too great for the brakes to stop the downward motion, crashed into the pit, causing considerable damage. Similar accidents have occurred on the up motion of heavily over-counterweighted empty cars. Unless the shunt winding is of sufficient strength to excite the fields to a point near saturation, considerable variation of car speeds may result under different loads with the series windings left active. Con-

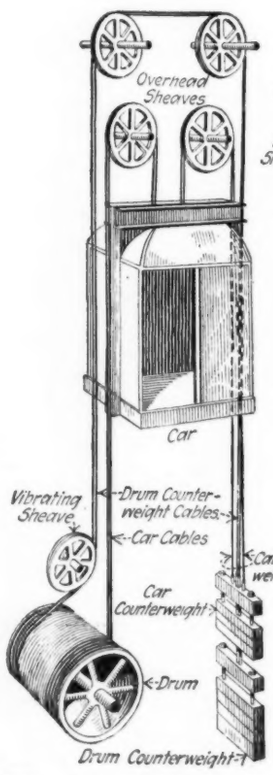


FIG. 1. LAYOUT OF DRUM-TYPE ELEVATOR

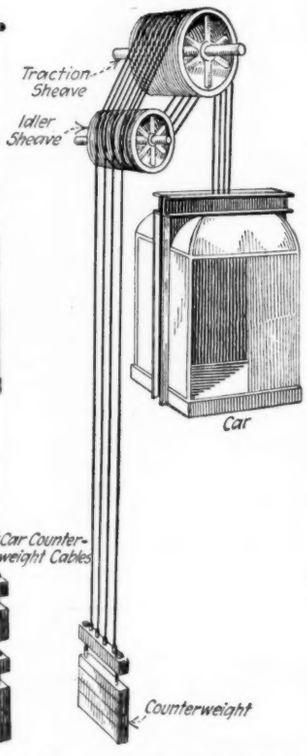


FIG. 2. LAYOUT OF TRACTION-TYPE ELEVATOR

sequently the motor used for elevator service is an intermittent duty machine, with the series fields wound for starting duty only, in which case burnouts may result from neglect to cut the compound winding out after starting.

Reversing the direction of the motor rotation is accomplished by changing the direction of the current through the armature, leaving the fields to build up always in the same direction. Where commutating-pole motors are used, the commutating-pole winding must, of course, be reversed with the armature.

The size of the motor required for a certain lift at a given speed may be easily figured as follows:

$$Hp = \frac{W \times S \times 2}{33{,}000}$$

where W is the load to be lifted and S the car speed in feet per minute. The multiplier 2 is used because the net horsepower figured must be doubled to take care

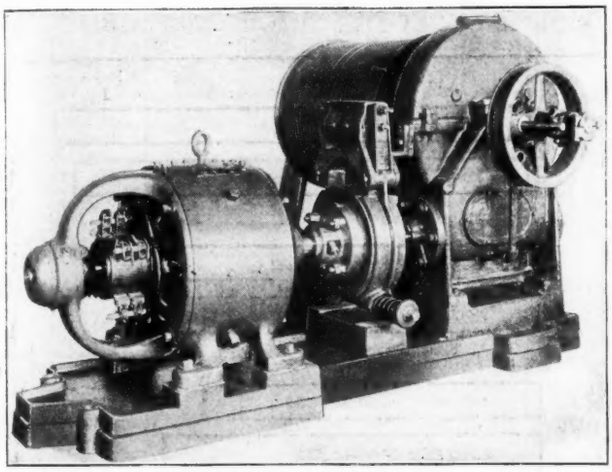


FIG. 3. DRUM-TYPE ELEVATOR MACHINE

of the frictional losses. This high factor is largely accounted for in the worm-gear reduction which, owing to the heavy thrusts, etc., is not very efficient.

Suppose a capacity of 1,500 lb. at 150 ft. per min. is desired. Assuming the counterweights will be proportioned in the customary manner to balance the car weight, plus 33 per cent of the maximum load to be carried, in this case an overbalance of 500 lb., the actual weight to be lifted by the motor will be 1,500 — 500 = 1,000 lb. Then,

$$Hp = \frac{1{,}000 \times 150 \times 2}{33{,}000} = 9.1$$

hence a 10-hp. elevator motor will be selected.

For elevators driven by alternating-current motors, the plain squirrel-cage type of induction motor, owing to its inherent simplicity and safety of operation, is to be preferred, where objections of the power companies do not preclude its use. The modern squirrel-cage motor, having a large "slip," and consequently high torque and rapid acceleration, designed especially for elevator and hoist duty, should, in the writer's opinion, overcome many of the power companies' objections, at least up to the 15-hp. sizes. This elevator motor on 60-cycle circuits has a no-load speed of 900 r.p.m. and a full-load speed of about 750 r.p.m. instead of the 850 to 865 r.p.m. of the industrial squirrel-cage motor. Where objections are raised, and for the larger-sized equipments, recourse is had to the slip-ring type of motor with automatic means of short-circuiting the rotor resistance as the motor accelerates. For two-speed operation, increasing use is being made of the induction motor, with a double-stator winding wound for two different numbers of poles.

Turbine-Gear Transmission

What is termed the A Turbo Transmission, designed for shaft and pump drive, is shown by the accompanying illustrations. It is manufactured by the B. F. Stur-

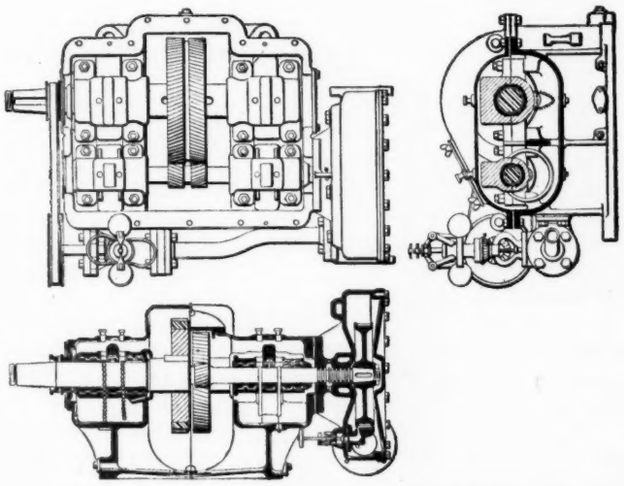


FIG. 1. DETAILS OF THE GEAR TRANSMISSION

tevant Co., Boston, Mass. This self-contained unit is compact and does away with turbine bearings and one turbine packing. The turbine and pinion shaft is supported by two bearings in the gear casing, but the turbine proper overhangs the gear casing at one end (see Fig. 1.) Two pinions are carried on the turbine shaft, and these mesh with two large gears carried on the gear

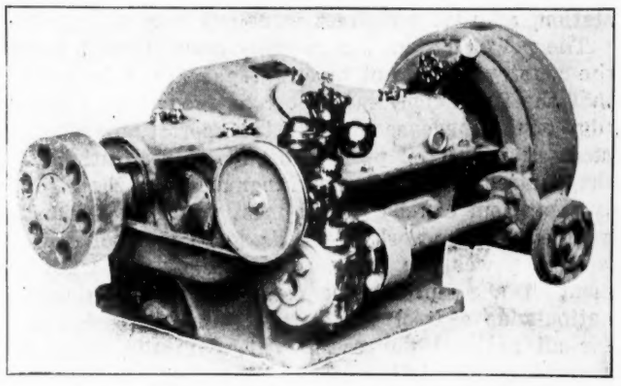


FIG. 2. TURBINE AND GEAR TRANSMISSION

shaft, which is coupled to the shaft or pump that is to be driven. Lubrication is confined to the transmission casing, the large gears dipping slightly into the oil. The machine is oiltight and dustproof and can be operated in places where it would be impracticable to run a motor.

This transmission is built in two sizes, 25 and 50 hp. It can be built in larger sizes, however. As shown in Fig. 2, the speed of the turbine is governed by a throttling governor that is driven from the gear shaft.

A Study of Power Development and Suggestions for Future Progress

By L. W. W. MORROW

Assistant Professor of Electrical Engineering, Sheffield Scientific School, Yale University

MODERN industrial civilization depends on four agencies: The transportation system, the factory system, the communication system, and the power system. Its present status is largely due to the development of the factory system brought about by the introduction of the transportation and communication systems, all of them depending on the power system.

The existing communication system is more adequate than the other systems as regards its ability to expand, and yet the wonderful advances in communication methods in the last few years seem to indicate that it is still in an embryonic stage of development.

The factory system has reached an advanced stage of development as regards production methods, and further progress can be made only through changes in other industrial conditions. Production depends on labor, transportation and power as regards factory location, and the last two elements are primary. This has resulted in the congested industrial districts.

The war proved the inadequacy of the transportation system to care for abnormal industrial expansion, not only because of missing mileage and rolling stock, but also because of inadequate methods and the coincidence of a transportation peak with an industrial peak. The transportation of fuel for power purposes necessitates the movement of more than 300,000 tons of coal daily. This, together with the fuel transportation for railroad locomotives, uses a large percentage of rolling stock for fuel for localized power production.

The industrial power system has had a haphazard and wasteful growth. It was incidental to production and transportation in that it, except in the central station, afforded no direct monetary return.

The power system has recently been brought before the country because of three things: (1) A knowledge that the fuel supply must be conserved; (2) a knowledge of the inadequacy of the transportation system to meet an industrial peak load; (3) a realization that the solution of both the workingman's and the capitalist's problem can be gained most readily by securing more output per worker; that is, greater use of power.

More power can best be obtained by the establishment of a comprehensive power system with unified nation-wide control for supplying power at low cost for all national purposes. This does not mean the scrapping of existing power-producing agencies, but it means the engineering grouping and expansion of such power sources as are existing, the addition of new power sources in proper locations for interconnected power production and the scrapping of small, inefficient plants not essential or economical for connection to the comprehensive system. Such an idea is being accomplished very rapidly at the present time simply through economic competitive conditions.

Adequate and cheap power on a comprehensive scale would mean: Better living conditions, as industries could be located in nonurban territory and the present tenement districts would be eliminated and the homes of the people would be made more comfortable through the use of power appliances in the home, whether city or country; better social and financial conditions, since the output per worker would be increased with a consequent wage increase. At the same time the price to consumers would decrease, as the cost of power is very small as compared to the cost of labor in manufacturing plants. Fuel would be conserved, because large power stations use fuel more efficiently than small ones. Also the fuel used for transporting a great part of the coal supply of the country would be saved, and undeveloped large and small water powers could be utilized by such a network power supply.

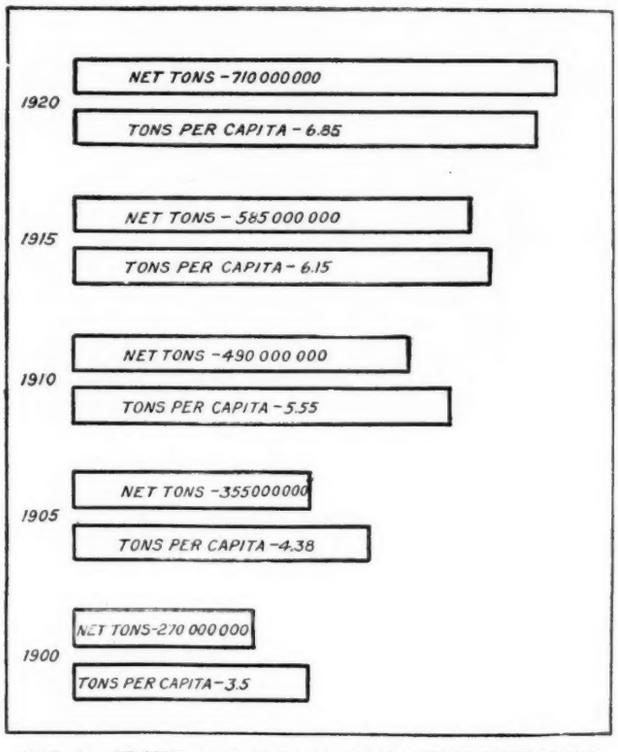


FIG. 1. GROWTH IN ANNUAL COAL CONSUMPTION IN THE UNITED STATES

Transportation congestion would be relieved through the expansion and relocation of congested industrial districts, through location of industries at raw material sources and by the diminished haulage of fuel. The factory system would be improved and developed. Cheap and reliable power would mean less cost per unit of output and more wages for the employee, less cost to the consumer and more return to the capitalist, thus increasing the inducement for industrial development.

The accompanying curves have been prepared to show present tendencies in power production and fuel consumption. Fig. 1 shows the net tons of coal used and the tons per capita. The ratio of the tons per

capita to the net tons is decreasing, owing to more efficient fuel utilization. In 1870, per capita, there was 1 ton of coal used; presumably, this represented the amount needed for heating purposes. In 1919, per capita, there was about 6.5 tons of coal used. The excess over the 1 ton needed for home comfort represents the change in conditions brought about by modern use of power in industrial work. The United States Geological Survey states that if the fuel consumption

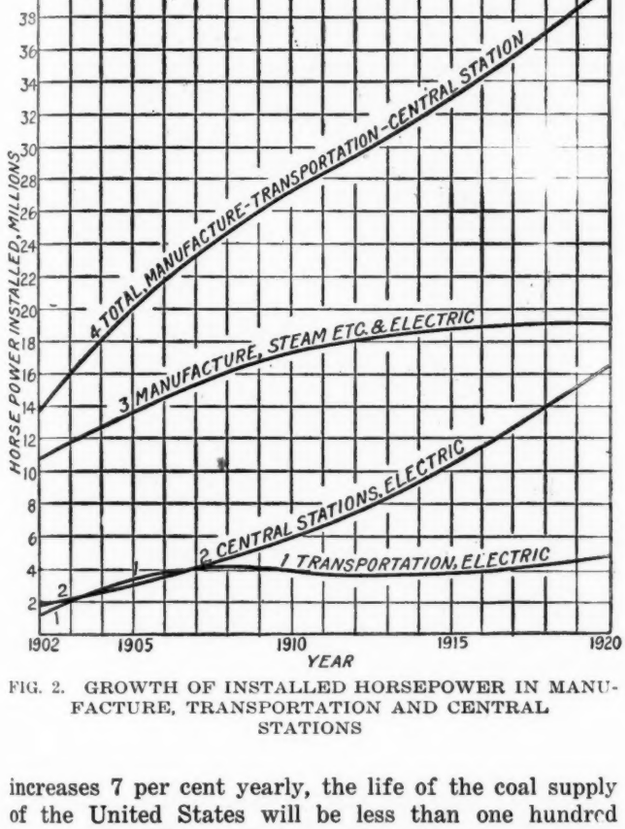


FIG. 2. GROWTH OF INSTALLED HORSEPOWER IN MANUFACTURE, TRANSPORTATION AND CENTRAL STATIONS

increases 7 per cent yearly, the life of the coal supply of the United States will be less than one hundred years. The effect of such an exhaustion on our industrial existence can be contemplated only with anxiety, particularly when it is understood that the United States has half the world's coal supply. Every effort, therefore, from a conservation of fuel standpoint must be made to obtain more power per unit of fuel.

Fig. 2 shows the growth of installed horsepower in the United States as obtained from the Census and current technical journals. Curve 1 shows the horsepower installed for railway and electrified trunk-line purposes. The increase during the last three or four years is due to the great increase in the electrified trunk-line mileage. Curve 2 shows the increase in the horsepower installed in central stations; it is growing at the rate of 1,200,000 hp. yearly, while the total horsepower installed in manufacturing plants, central stations and railway plants (curve 4) shows an increase of only 1,300,000 hp. yearly, thus indicating the trend of power development toward central stations. Curve 3 shows the installed horsepower in manufacturing plants aside from rented power from central stations. Until 1910 factories put in their own power plants, but since that time the greater number purchase their power from central stations, as indicated by the curves.

Fig. 3 shows the history of the installed horsepower used for manufacture in the United States. Curve 1 shows the remarkable growth in the use of internal-combustion engines as sources of power for manufacturing purposes. Curve 2 shows that the direct use of hydraulic power in manufacturing is practically constant. In New England there has been a decrease in the use of water power in factories, due chiefly to the small capacity of the older developments and their inability to meet the demands of factory expansion.

Curve 3 shows the total electric horsepower used in manufacture and is the sum of the dotted curves labeled "Generated Electric" and "Central-Station Electric" respectively. The total electric power is increasing at the rate of 1,200,000 hp. yearly as compared to a rate of only 600,000 hp. yearly for all horsepower used in manufacture. Of this total electric power the increase of purchased power is indicated by the dotted curve labeled "Central-Station Electric." The curve labeled "Generated Electric"

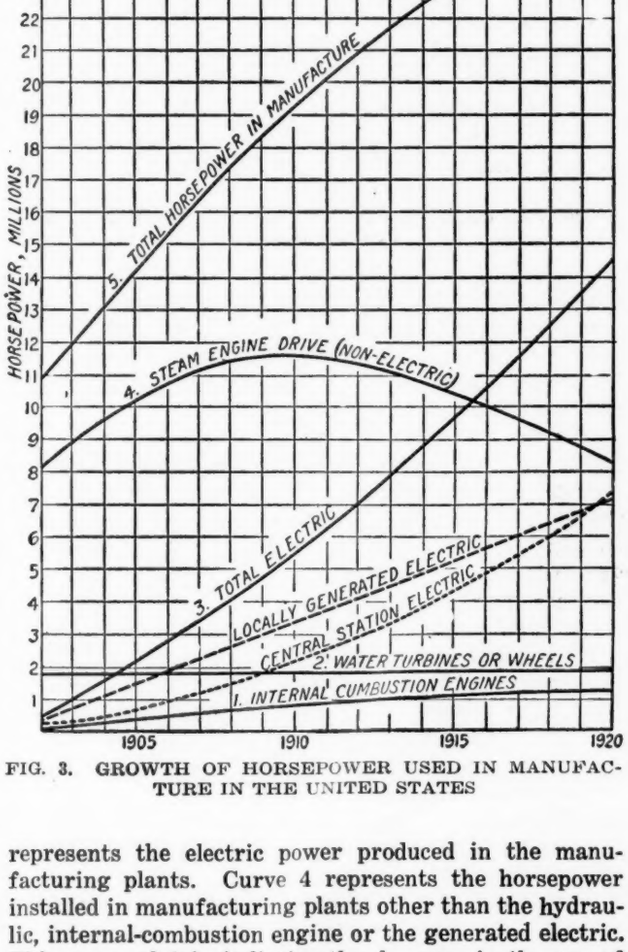


FIG. 3. GROWTH OF HORSEPOWER USED IN MANUFACTURE IN THE UNITED STATES

represents the electric power produced in the manufacturing plants. Curve 4 represents the horsepower installed in manufacturing plants other than the hydraulic, internal-combustion engine or the generated electric. This curve plainly indicates the decrease in the use of steam-engine drive for manufacturing plants. The figure shows clearly the tendency toward electric power in manufacturing, brought about solely by competitive and production conditions. Electricity, as such, is getting to be an important element in many manufacturing processes, and this fact aids the movement toward an electrified industry.

The figure shows that central-station electric power in manufacture is rapidly replacing all other types and that the economic solution of the power supply for manufacture is obtained by using such power.

Fig. 4 shows the trend of central-station development. A comparison of installed horsepower curves on Figs. 3 and 4 shows that where the total power installed in manufacturing plants is increasing at the

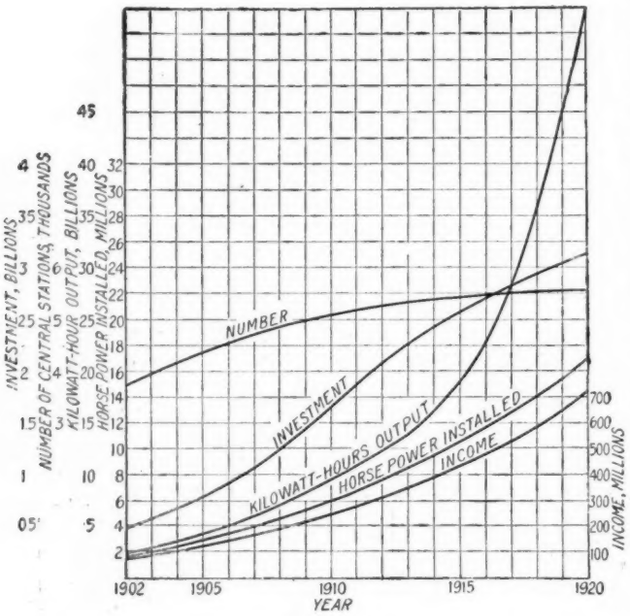


FIG. 4. GROWTH OF CENTRAL STATIONS IN THE UNITED STATES

rate of 600,000 hp. yearly, the power installed in central stations is increasing at the rate of 1,400,000 hp. yearly. The increase in the central-station power can be largely accounted for in the increased amount used in manufacture and in transportation.

The number of central stations is increasing slowly as is the investment, showing the tendency toward concentration now occurring in central-station development. The most remarkable curve on Figure 4 is that showing the kilowatt-hour output. The remarkable yearly increase shown by this curve as compared to the increase shown by the installed horsepower curve shows vividly the effect of wartime economy in operation as well as the effect of increased industrial load on the load factor of central stations. A comparison of the kilowatt-hour curve with the income curve shows that more power means cheaper power. Income increases twice in about 6.5 years, while the kilowatt-hour output increases 26 times in the same period. The kilowatt-hour output is increasing at the rate of six billions per year as compared to the 1,400,000 installed horsepower increase yearly.

If this six billion kilowatt-hour yearly increase is to be cared for by small central stations operating on a basis of 6 lb. of coal per kilowatt-hour, it would require an increased yearly coal demand of eighteen million tons. If the same demand is met by a large central station installation the yearly coal increase on a two-pound basis would be only six million tons. Thus a considerable saving in fuel is possible by utilizing large and modern stations as compared to small, inefficient stations.

The figures show clearly the trend in power development toward a national and comprehensive power supply. This trend is also evidenced by statistics of developments in widely separated parts of the country.

In New England during the last three years one company has discontinued 121 small and inefficient steam stations by interconnection and regrouping of existing power sources in their territory. Nearly every New England State now has its power systems interconnected, and there is a general tendency toward still further consolidation. In Alabama a network power system with more than 1,000 miles of power lines and 150,000 kva. capacity is in successful operation. At Niagara Falls over 500,000 kva. is connected and used for power purposes in a large territory. In the Northern Illinois district more than 500,000 kva. is in one system. On the Pacific slope immense power systems are connected together to form a network from Oregon to southern California.

The technical problems associated with a comprehensive national power system are largely solved as regards apparatus. The unsolved problems lie in the direction of control and protection to secure reliable service under all conditions and do not give evidence of great magnitude. Social and political conditions are the greatest handicaps, and the utility managers will be called upon for closer co-operation in such a scheme than has been obtained in the past. Government regulation of public utilities will have to change its character before any such project can be financed. Regulation is necessary, but it should stimulate, not retard, development.

The country must be awakened to the resulting benefits of an adequate power supply. The present antagonism of the people toward all public utilities must be removed through unfailing efforts and a truthful educational campaign. Such a scheme is everyone's business yet no one's business, as it is on too large a scale for individual enterprise. Despite this fact the figures presented show clearly the tendency in the proper direction, and every endeavor should be made to expedite the change simply from a social and conservation standpoint.

Cooling Coils for Water-Cooled Transformers

The Electrical-Apparatus Committee of the National Electric Light Association enumerates the advantages and disadvantages of copper and iron cooling coils for transformers as follows:

Copper cooling coils have the advantage of non-corrosibility, the disadvantage of high first cost and are limited to a pressure of about 250 lb. per sq.in. maximum. In the iron cooling coils corrosion will take place where the water is unsuitable, principally due to excess air in the water, unless precautions are taken, and these may not always be successful in eliminating the trouble. The advantage in the use of the iron coils lies in lower first cost and the ability to stand a maximum pressure of approximately 1,000 lb. per square inch.

The subcommittee recommends the use of copper cooling coils wherever the water conditions are unknown, always bearing in mind the limits of the copper coils where high heads of water have to be considered. Iron coils of less than one inch internal diameter should not be employed.

Twelve-Inch High Pressure Underground Steam Main

IN 1917, Day & Zimmerman, engineers, put in operation the new Front Street Station of the Erie Lighting Co., in which is installed 20,000 kw. in turbines. It soon became apparent that much greater economy could be effected by combining this new station with the company's older Peach Street Station on account of the higher efficiency of the new plant. Several plans for accomplishing this were considered, and it was finally decided to connect the 8,500-kw. turbines in the old plant with the new boiler plant of 5,076 hp., normally operated at 300 per cent rating, by what is virtually an underground steam header. The installation of this high-pressure underground main has recently been completed by the American District Steam Co.

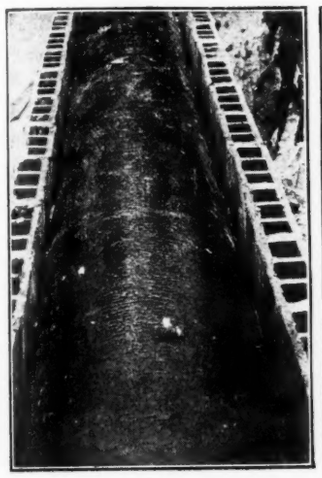


FIG. 1. SIDES OF MULTICELL CONDUIT

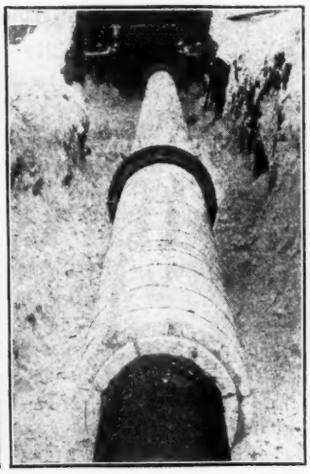


FIG. 2. TWO LAYERS OF COVERING

Ground was broken in October, 1919, and construction began on the specifications for a 12-in. line, 1,600 ft. long, to carry a maximum operating pressure of 250 lb. 225 deg. superheat, and to deliver 250,000 lb. of steam per hour.

The main is installed along the lake front, part of it being below the lake level. A large amount of mud and water was encountered during excavation, making tight sheathing necessary. To relieve the water pressure from the exterior of the completed conduit, a subsoil of coarse stone and gravel, 18 in. in depth, drained by tile and sewer lines to a sump, was placed in the bottom of the trench, and upon this foundation the concrete base of the multicell conduit, Fig. 1, was constructed. The sump is automatically pumped out as water accumulates.

The conduit is constructed of a hard-burned hollow tile resting on a concrete base. The tile were specially manufactured for this purpose and are laid in cement mortar. To prevent water from entering the conduit a membranous waterproofing is used, so applied that the conduit is thoroughly sealed by two layers of waterproofing felt and one layer of burlap hot-mopped into place with pitch. To prevent the weight of the conduit from puncturing the membrane the concrete base is made in two sections, an upper and a lower, and the membrane passed between the two. The portion of the concrete below the lake level is surrounded by a concrete envelope five inches thick, the primary purpose of which is to protect the waterproofing membrane.

Nonpareil covering is used. This is applied in blocks, two layers thick, held in place with wire, all crevices being filled with cement, Fig. 2. Waterproofing of the covering is accomplished by applying two layers of high-grade roofing, each layer mopped in place with high-temperature asphalt varnish, all joints being broken. As an additional insulation the interior of the conduit above the center line of the steam main, also the voids in the multicell tile, are packed with dry "nonpareil."

The steam pipe is extra-heavy, strictly wrought-iron line pipe, and the joints are made by electric-arc welding, Fig. 3. There are no thread connections in the main, and the number of flanged joints is reduced to a minimum, such joints being necessary only at the expansion joints and elbows. All flanges are extra-heavy cast steel.

Expansion of the main pipe line is taken care of by the use of thirteen extra-heavy cast-steel duplex-sleeve expansion joints, Fig. 4, and built to take care of a maximum of eight inches of traverse. The expansion joints are anchored to the concrete side walls of the manholes by specially designed steel anchor wings. The feature of these patented joints is that the slip, or moving element, consists of an inner and an outer sleeve of forged steel treated with a rustproof process and highly polished, with $\frac{3}{8}$ in. air space between the two sleeves. The object of this construction of the slip is to prevent the packing coming in contact with the high temperature (approximately 700 deg. F.) to which the inner sleeve is subjected. With a temperature reduction of approximately 40 per cent on the outer side of the outer slip, the life of the packing is indefinitely increased. Flanges are eliminated from the movable end of the expansion joint, the inner sleeve being welded directly to the pipe line.

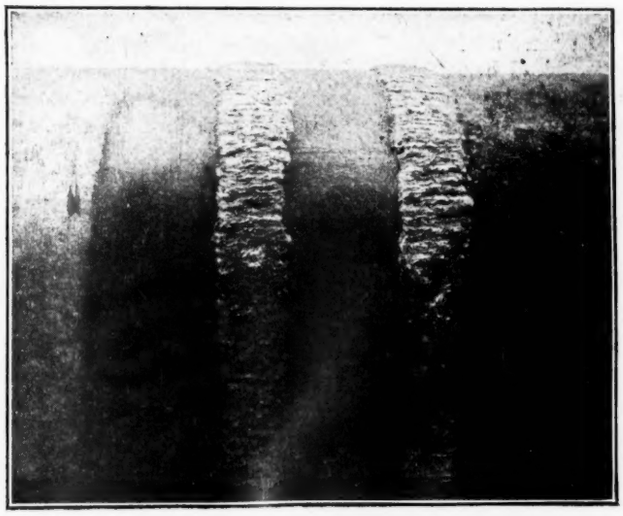


FIG. 3. ELECTRIC-ARC WELDED JOINTS

All fittings and expansion joints are installed in large concrete manholes with reinforced-concrete tops, waterproofed to the surface in the same manner as the conduit. Special watertight manhole curbs are used, having inner and outer covers, the inner covers being thoroughly packed, thus preventing surface water from entering the manholes.

It has been the experience of the engineers that long runs of pipe under the expansion variations of high

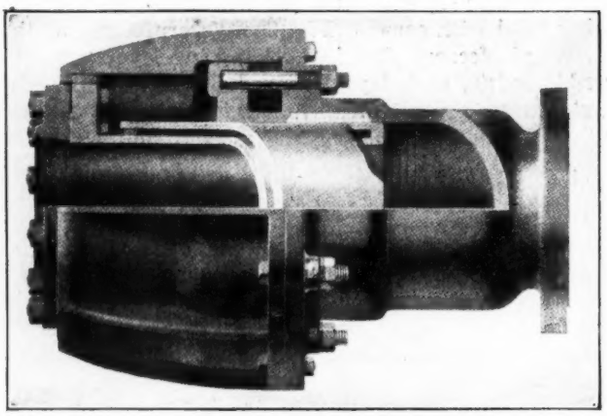


FIG. 4. DUPLEX-SLEEVE EXPANSION JOINT

temperatures "weave" in travel, thus distorting alignment and creating packing and gasket troubles. To eliminate this condition, there are placed at intervals averaging 30 ft. alignment guides, Fig. 5. These guides consist of semi-steel shells bolted to the concrete base by means of anchor bolts. Attached to the pipe and moving freely through the shell of the guide, with proper clearance, are semi-steel clamps supporting the pipe concentrically in the guide by means of four points or lugs.

At ten-foot intervals saddle plates, rollers and chairs are placed beneath the main as additional support and assistance in the free movement of the pipe, due to expansion and contraction. Nine angles are in the line made by the use of bent pipe and extra-heavy cast-steel sweep elbows, with large anchor bases especially designed for the work, Fig. 6. These bases are anchored in concrete foundations, and all anchors are thoroughly backed up by large concrete abutments.

The company has had this underground steam line in operation for eight or ten weeks, and has closed down the boiler plant at the old station and done away with the services of twenty-two men. Inasmuch as the new boiler plant is more efficient than the old one, the saving due to the operation of this underground line will amount to several thousand dollars per month.

New York Lighting Companies Use 3,453,408 Tons of Coal in a Year

More than three million tons of coal and coke was used in the manufacture of gas and electricity by the various gas and electric lighting companies in New York City in 1919, according to reports filed with the Public Service Commission. Of this tonnage the gas companies used 1,645,619 short tons of coal and coke, and the electric lighting companies used 1,806,789 short tons of anthracite and bituminous, a total of 3,453,408 tons.

In addition to the consumption of coal and coke the gas companies in Manhattan and The Bronx used 14,254,558 gal. of water-gas tar and 129,233,034 gal. of gas oil in the making of gas, while the companies in the other boroughs of the city used 12,305,157 gal. of water-gas tar and 88,785,797 gal. of gas oil, a total of 26,559,715 gal. of water-gas tar and 218,018,831 gal. of gas oil.

Three of the gas companies made 378,438 tons of coke during the year, of which they sold 119,479 tons for $669,660.03, an average of $5.59 per ton.

The reports show that the various electric lighting companies consumed the following tonnages:

	Anthracite	Coal	Bituminous
New York & Queens Electric Light & Power Co.	6,441	.....	1,770
New York Edison Co.	.....	948,651	.....
United Electric Light & Power Co.	.....	334,553	.....
Flatbush Gas Co.	21,242	.....	1,657
Brooklyn Edison Co.	16,428	.....	427,618
Queens Borough Gas & Electric Co.	.....	.....	15,154
Richmond Light & Railroad Co.	33,275	.....	.....
Totals	77,386	1,283,204	446,199

FIG. 5. ALIGNMENT GUIDE IN POSITION

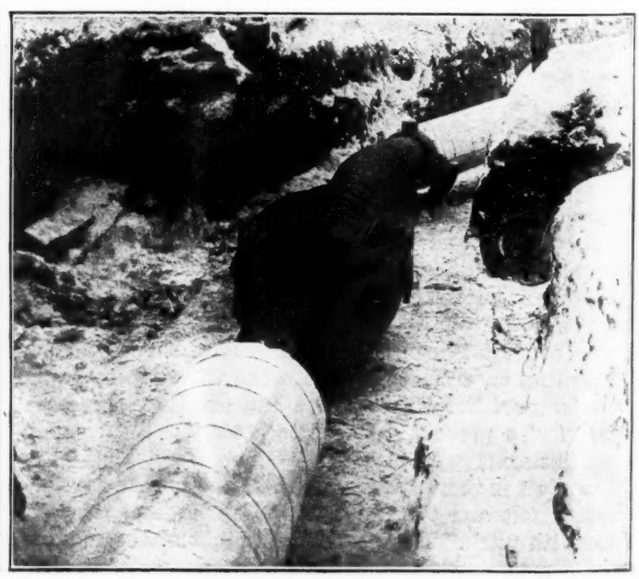


FIG. 6. EXPANSION JOINT AND PIPE BEND

A Real Steam Man—Edward F. Miller

A Teacher of Heat Engineering Who Has Never Lost Close Personal Touch with the Industries

WHEN the United States actively entered the war with Germany, thousands of men, big and little, left their jobs and entered the service of the Government, both in civilian and in military lines. Others carried on their regular work and shouldered heavy extra burdens in the service of the country. The Government needed the former class of men, but it also needed badly the latter class—men who could do their share toward keeping the industries and business of the country running and who were big enough to give, in addition, helpful service toward winning the war. Among this latter class is Edward F. Miller, Professor of Steam Engineering and Head of the Department of Mechanical Engineering at the Massachusets Institute of Technology.

Ever since his graduation from the Institute in 1886, Professor Miller has been connected with its teaching staff, where, after serving as Instructor, he was given the title of Assistant Professor of Steam Engineering at the age of 26. In 1911 he was put in charge of the Department of Mechanical Engineering, under which is included all instruction in mechanical engineering, applied mechanics and mechanic arts, or as the graduates of fifteen years or more ago remember it, "shop-work."

One of his characteristics has always been the ability to do a little more work. In addition to his duties as a teacher, Professor Miller has found time to do a great deal of extra work in consulting engineering. He has conducted a large number of boiler and plant tests, both for research purposes and as acceptance tests. He has served as expert in many accident cases, especially in connection with boiler explosions. He has been called as an expert witness in numerous lawsuits involving engineering questions. It has been said that no cross-examining lawyer ever succeeded in mixing up his testimony on the witness stand. He has also done a large amount of research work in the engineering laboratories at the Institute, having made a number of investigations on the capacity and action of safety valves, involving the handling of steam, air and ammonia. He has made exhaustive experiments on the flow of ammonia in pipes. In short, his activities have covered every part of the broad field usually included under the term heat engineering, and his experience has been such as to rank him as an expert in any part of that field.

A great many people think of a college professor, even an engineering professor, as an impractical theorist who lives in the clouds. Professor Miller's long experience with the practical problems of engineering, not only in the laboratory but actually in the industries, has removed all traces of the impractical dreamer, if ever there were such traces in his make-up. He meets his students as a very human man, not as a theorist from another world. When he is explaining a point of theory from the lecture platform, his own experience can always furnish one or more actual examples to illustrate it.

Probably the biggest physical monument to Professor Miller's work is the group of engineering laboratories in the new "Technology" buildings in Cambridge. As far back as 1912 drawings and studies of the "New Technology" began to be made. From then on much of his time was devoted to the laboratories, and after the actual construction of the new buildings began he almost "lived on the job." The largest of these laboratories is that devoted to steam, air and hydraulics. In addition are the laboratories for gas engines, for testing materials, for mechanic arts, for textile machinery and for power-transmission machinery. The present success of these laboratories and any success they may have in the future must be credited very largely to Professor Miller's personal efforts.

"Technology" occupied its new buildings in the fall of 1916, and the school year of 1916-17 was full of the problems of readjustment and the completion of

unfinished details of construction and installation. In the spring of 1917 came the entrance of the United States into the war. The Institute authorities at once placed their entire resources of equipment and personnel at the service of the Government. Various schools were established, some completely under Army or Navy control and some handled partly by the regular staff. Some of the drawing rooms and class rooms were used as dormitories for uniformed details receiving special training. Parts of the laboratories were partitioned off and devoted to secret research and instruction work. The regular schedule of work was completely rearranged on an intensive basis to hasten the graduation of engineering students, that they might be available for needed work at the earliest possible moment.

As the head of the Department of Mechanical Engineering a large proportion of this work fell on Professor Miller's shoulders, but the demands on him did not end there. He was continually called on for advice and help by the War and Navy Departments. He spent a great deal of time in the design of experimental fighting machinery for the Ordnance Department. Much of this work was done in secret, and most of it will probably never be known beyond a small circle of army officers, so that the full value of his service cannot be appreciated by the public in general.

When every effort was being made to build a "bridge of boats to Pershing," it was realized that boats without men to run them would be helpless. It was important that these men, and especially those in authority, should be loyal Americans, and the number of skilled marine engineers and navigators was woefully small. The United States Shipping Board therefore established schools for the intensive training of men for these positions. Again Professor Miller was called on, and he was made Chief Instructor of all the Shipping Board Schools for the training of engineering officers. This meant responsibility for the organization of all of these schools throughout the country, immediate responsibility for the local one at "Technology" and even personally giving a number of the lectures. So successful were these schools under his leadership that, although the emergency has passed, the school at Boston is still maintained to help in furnishing engineers for the growing American Merchant Marine.

The war over, he settled down to the problems of reorganizing his department at "Technology" to meet the unprecedented rush of students to the engineering schools. This was complicated by the tangle left from the numberless makeshifts necessary for the wartime emergencies. This work was still under way when the sudden death of Dr. Maclauren, President of the Institute, brought new responsibilities. The corporation entrusted the administrative powers of the president's office to a committee of three members of the faculty, and Professor Miller was made a member of this committee.

At the time of his death Dr. Maclauren was just about to undertake the reorganization of all the Institute's work, which was made necessary by the increase in the number of students and the economic conditions that have faced all the colleges. This stupendous task fell on the shoulders of the administrative committee in addition to the departmental work of each of its members. This work is still going on as this is written, but the number of expressions of approval heard by the writer from people connected with the Institute indicates that the committee is fully capable of carrying out this important task as well as the others entrusted to it.

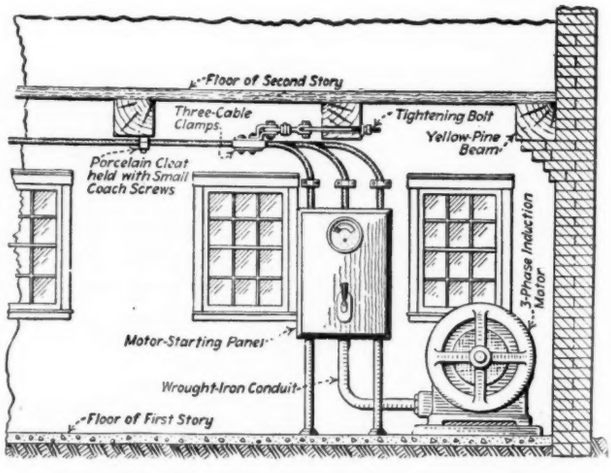
With Prof. C. H. Peabody he is co-author of the first edition of a textbook on Steam Boilers, succeeding editions being his own work. He has also written numerous sets of notes on various subjects for the use of his students. These notes, while not formally published as books, form a valuable collection of engineering literature and are to be found in the libraries of many "Technology" graduates of recent years, as well as in the collections of many of the older men who have been so fortunate as to be able to obtain them.

Professor Miller was born in Somerville, Mass., in 1866 and has always lived near Boston. He is a member of the Engineers' Club and of the University Club of Boston, of the American Society of Mechanical Engineers, the American Society of Civil Engineers and the American Society of Refrigerating Engineers. In connection with the American Society of Mechanical Engineers he has done considerable committee work, especially on the Boiler Code Committee and the Power Test Code Committee, being a member of the subcommittee of the latter on Refrigerating Machinery and Apparatus, as well as of the main committee. He is also a life member of the Massachusetts Charitable Mechanics Association and has been elected an honorary member of the National Association of Stationary Engineers.

Dead-Ending Conductors to Floor Timbers

BY ROY J. TURNER

A convenient and economical method of dead-ending large slow-burning insulation conductors on the floor timbers of a wood-frame building over the switchboard



METHOD OF TERMINATING MOTOR CONDUCTOR

for a motor is indicated in the illustration. The cable clamps in combination with an I-bolt provide a means whereby the conductors can be drawn taut, and their application renders unnecessary any "making up" of the heavy conductors. Note that no copper is wasted in making such a termination.

EDITORIALS

Super-Power Project One of Many Angles

WHEN electrical power is to be generated from fuel the most economical method involves many considerations. If it is only a question of producing large quantities of power for industrial and domestic purposes, there is no other way in which it can be done so economically as in large stations centrally located with reference to the load and coal and water supply. In such plants the greatest advantage can be taken of the high efficiency of large turbo-units operated condensing in a high vacuum. Where large volumes of steam are required for heating and manufacturing processes, the most economical operation is obtained in plants from which both power and heat are supplied. Under the latter conditions power may be considered a byproduct. With steam turbines operating condensing about the best over-all thermal efficiency so far attained is twenty per cent. In the plant where the engines act as reducing valves for the heating system, an over-all thermal efficiency of sixty to seventy per cent is possible. However, where the exhaust steam is used for heating only, unless conditions are favorable to operate the plant condensing, during the summer months the thermal efficiency is so low that the gain during the winter months is lost. Therefore, if it could be successfully worked out, the most economical plan would be for the industries to buy their power from the central station during the summer months and generate their own during the season when heat is required.

In a comprehensive project in which all the power requirements for a given district are to be supplied from a super-power system such as proposed by W. S. Murray for the industrial district extending from north of Boston to Washington, D. C., where advantage can be taken of all the loads in this region it should be possible to develop a system that would enjoy the benefits of the high efficiency of a combined heating and power load. Such a project as the proposed super-power system will supply power not only for industrial needs, but also for the various transportation lines. During the winter months when heat is required, approximately thirty-three per cent more power will be needed than in the summer months. This railroad heating demand comes at the same time as the heating load of the industries. Consequently, if the local industries could be supplied with heat and power from the same plant during the winter months, either from an isolated plant in one industry or from a centrally located plant serving a number of industries, a large amount of the central-station capacity could be released to supply the railway heating load. Practically the only additional cost for equipment in the heating plant would be that for the engine and generator, which need be only of sufficient size to supply the required amount of exhaust steam for heating, and can be installed and operated at minimum cost. Since this plant will be tied into the central system, no emergency capacity need be provided. These heating power plants could no doubt, be installed for practically the same cost as additional capacity in the central stations, or even less. In the heating plant the addition of the power-generating equipment is all that will be required, where in a central station complete boiler and generating equipment will have to be installed.

In this super-power system all available water power must be developed for the maximum number of kilowatt-hours economically possible. The low-water periods of our rivers in the Northeastern states generally occur during the winter months. Consequently, considerable reserve steam power-plant capacity will be necessary to take care of the load during this period, which also coincides with the industrial heating load. This reserve steam-station capacity can be obtained by transferring part of the central-station load to the heating power plants in the winter months, thereby reducing the amount of reserve central-station capacity.

Whether the large central stations are installed at the mines or in the large industrial centers, or whether all the power for domestic and industrial purposes is supplied from these stations, coal for heating must be hauled by the railroads for domestic and industrial heating. Since the purpose of this proposed super-power zone is to conserve coal and relieve railroad congestion, both of which are of paramount economic importance to this country at the present time and will be increasingly so in the future, every factor that is conducive to this end should be carefully considered, irrespective of private interest or personal prejudice. Although it is realized that one hundred per cent efficiency cannot be obtained for every element entering into the problem, the equation that will offer the best solution must give the correctly weighted value to each component.

Corrosion Research

WHAT disease and decay are to the human body, corrosion is to the mechanical structure. A scientific, systematic investigation of the causes, manner and prevention of corrosion is of no less moment to the engineer and those who use products of his skill than are the investigations of which it is sought to reduce the number and virulence of the ills that flesh is heir to, and to promote health and longevity.

The Corrosion Committee of the Institute of Metals, of Great Britain, has been at work for ten years with promising prospects of attaining results that will be of wide and beneficent importance. Its activities have been financed first by the Institute of Metals, then by the Institute in conjunction with the makers of condensers and condenser tubes, to the corrosion of which much of its attention has been directed, and the government department of Scientific and Industrial Research. An appeal is now made to the users of condensers as well, and the government agrees to contribute a like amount for every pound contributed by the users.

Surely, the prevention or retardation of the corrosion of condenser tubes is of as much importance to the

user of condensers as to any other class. By far and large it is of general effect, for it is an element of cost in marine transportation, in the production of electricity, and of many articles in the manufacture and distribution of which condensers are directly or indirectly used. Furthermore, such an investigation by specialists daily growing wiser and more expert in the subject offers the best mode of attack upon corrosion in general, the conquering of which would be of such vast importance to engineering and everything dependent upon it.

We hope that the appeal of the committee will find a generous response and that its work will be carried to a positive and effective conclusion.

Co-operation Among Engineering Societies

ONE of the features of the recent spring meeting of the American Society of Mechanical Engineers in St. Louis was the joint session with the American Society of Refrigerating Engineers and the American Society of Heating and Ventilating Engineers. This was not the first occasion on which such joint meetings of two or more national engineering societies have been held, but it is worthy of notice as one of the evidences of the growing spirit of co-operation among such national societies.

Students of history remind us that the original engineer was a civil engineer and that his interest was principally confined to hydraulics. As mankind progressed, the field for the engineer broadened and gradually different men devoted their attention to different features of the work. This resulted in the formation of groups whose members were interested in the same problems. These groups grew and in turn divided into smaller groups, each claiming a distinctive name and gradually forming societies and associations among themselves. As a result we have national societies of civil, mechanical, electrical, mining, heating and ventilating, and refrigeration engineers. The list might be extended almost indefinitely.

Each of these societies tries to cover only its own subject because no man can hope to comprehend the whole field of modern engineering. The trouble comes, however, when we attempt to fix the limits of any one branch. As an example, take the mechanical engineer who specializes on steam power plant work. He must, of course, understand boilers, engines, etc. If his plant be run condensing, however, he must arrange for handling large quantities of cooling water, which involves hydraulics, a civil engineering subject. If he installs generators, he invades the electrical engineer's province. The treatment of feed water to avoid scale and corrosion and the combustion of fuel are chemical problems. Try as he may to be a specialist, the engineer must keep in touch with the other branches of engineering if he is to solve his own problems.

The object of each of the great engineering societies is the helpful interchange of ideas and experience so that each individual may have the benefit of the knowledge of the other members. In the same way each engineering society can benefit by the interchange of ideas with the other societies. Modern civilization is built on co-operation. In addition most of its vital problems are engineering problems. Therefore co-operation among engineers would seem to be one of the essentials for the progress of our civilization. Evidences of such co-operation as the meeting referred to, as well as the other co-operative activities of the various societies, show that engineers realize their responsibilities and are trying to live up to them.

Be Careful

THE faster you go the greater the risk. Ordinarily, it is safer to walk than run, safer to run than ride a horse, safer to ride a horse than an automobile or railway car, safer these than the airplane. To play safe, greater care must be exercised the faster you go. This is true of traveling and of industrial operations.

We might relax vigilance if the world would slow down a bit, but as civilization has attained a goodly speed and accelerates as time goes on, the individual cannot slow down just so he may be less careful.

You cannot safely sit in the middle of Fifth Avenue—unless you are going with the current.

The public utilities of New York and Pennsylvania have set aside this week as "No Accident Week." Their employees and the public are appealed to to be careful, to avoid heedlessness and negligence, which not only endangers the safety of the person guilty, but which menaces the safety of others and jeopardizes property.

The appeal to guard life or health or personal safety gets an immediate response. The appeal to safeguard property against preventable damage or ruin needs particular emphasis, especially at this time. There are many factors that contribute to a serious situation arising in such cases. The freight tie-up, the shortage of labor, the unavailability of materials, the high cost of parts or whole machines—all these mean that quick replacement is practically impossible, service may be down and many hands made idle.

Power-plant employees as a class certainly deserve praise for the excellence of their training and the observance of caution. Few other branches of human activity have a higher percentage of careful, long-headed, common-sense men.

Every week is no accident week in the power plant.

An analysis of sixty of the large electrical power systems in the United States shows that forty-nine generate sixty cycle, six generate twenty-five cycle, four generate sixty and twenty-five cycle and one generates fifty cycle alternating current. There are approximately four and three-quarter million kilovolt-amperes of sixty-cycle, one and one quarter million kilovolt-amperes of twenty-five cycle, and one hundred and sixty thousand kilovolt-amperes of fifty-cycle generating capacity installed on these systems. If we are going to standardize on a frequency, why not sixty cycles especially, since this system predominates to such a large degree, and is as well, if not better suited to general power requirements than any other?

Figures based on reports obtained from over three thousand central stations give an average of three pounds of coal per kilowatt-hour. The most economical plants are operating on about one and one-half pounds. There is evidently an opportunity for improvement in the operation of the average central station as well as the isolated plant.

CORRESPONDENCE

Distance of Boiler from Grates and Bridge-Wall Height

The letters regarding the distance of a boiler from the grates, also the height of the bridge wall, are of particular interest to me, but I do not think that we can come to any definite conclusion regarding the matter that will be correct in all cases, as it is possible to find some old boilers in operation that are set low, and with a bridge wall almost touching the shell, and that show very good efficiency. Others are not giving even fair results, which would tend to indicate that there are things about a boiler other than the combustion chamber, that affect fuel economy. I have proved, at least to my own satisfaction, that other conditions have to do with the best height of bridge wall and boiler setting.

A number of years ago I had charge of a plant consisting of six old return-tubular boilers. These were set low over the fire, and the bridge wall was so close to the boiler (about four inches) that the fireman, when cleaning, could not push a hoe between it and the boiler at the center. We had an old Corliss engine and burned something less than 2 lb. of coal per indicated horsepower per hour with only 80 lb. gage pressure at the throttle.

Finally, we thought it advisable to renew our boiler plant, and the manager of the works employed some very technical engineers, who came and looked us over and laughed at our poor old boilers and their settings. As a result of much talk, many pictures and blueprints —and I would not leave out the wise expressions—we installed four 84-in. boilers, set 3½ ft. above the grate, and with the bridge wall 20 in. below the boiler. With 100 lb. pressure the best we could do was 2½ lb. of coal per indicated horsepower per hour.

One of the technical fellows put up the same argument that was advanced by one of the writers in the April 13 issue of *Power*; that is, that the reason we burned more coal was that the bridge wall no longer acted as a damper. Poor comfort, but the fact remained that we did burn more coal, and the theory as to why was of considerably less interest when it came to paying the coal bill.

Now, I am not taking the stand that low boiler settings are the best, as I have had experience that would seem to prove the opposite, but I think the draft, the amount the fires must be forced and the quality of coal used, as well as other conditions, have much to do with the most efficient height for bridge walls and boiler settings.

LEIGHTON JOHNSON.

Exeter, N. H.

United States Geological Survey Power Statistics

In writing regarding the power data of the United States Geological Survey, page 735 of the May 4 issue of *Power*, Mr. Misostow evidently was under a misapprehension as to certain facts with reference to these figures. He apparently believes that a considerable amount of fuel reported in these figures is used for purposes other than power production and undertakes to explain the large difference in efficiency between certain states and the less populous states, such as North Dakota and Montana, on the ground that much of the fuel is used for central heating plants or ice manufacturing.

In asking for reports from the public utility companies, the Geological Survey specifically requests as follows: "When fuel is used, report only the fuel used for generating electricity for public-utility purposes." From this it is evident that the Geological Survey recognizes the possibilities of other uses of power by the companies reporting and has taken precautions to eliminate this as fully as possible. As a matter of fact, it is doubtful whether more than 10 per cent of the fuel used in any state by these companies reporting is consumed for such auxiliary uses as are mentioned in Mr. Misostow's comment. It seems very unlikely, therefore, that anything more than a negligible percentage of error could be introduced from this cause, even if all the companies reporting made the mistake of including in their reports all fuel instead of only that fuel used for generating current. There is no doubt that some of the exhaust steam is used for auxiliary purposes, but under the circumstances no large differences are probably caused by this fact.

The only measure of electric power-plant efficiency which is commonly significant is the kilowatts generated per ton of coal used, or the equivalent reciprocal, pounds of coal used per kilowatt-hour generated. If one wishes to express the efficiency in percentage, he might, of course, convert the kilowatt-hours into the equivalent B.t.u. and also figure the B.t.u. in the coal used and thus get a measure of the percentage of the original heat found in the energy sent out. This would be a significant figure, but rather an unusual form of expression of power-plant efficiency. To add to any such percentage efficiency any additional thermal recovery in the form of exhaust-steam heating or other auxiliary service rendered is, of course, entirely proper. Indeed it is desirable in the analysis of a single plant in contrast with others, but under the conditions of work done by the Geological Survey it is impracticable

to take account of this supplementary activity, which is probably a small percentage in any event.

The fact which has been brought out by Mr. Misostow that the larger plants undoubtedly operate with higher efficiency, is of course correct. This probably accounts for practically all the difference between the conditions in the different states. However, it does seem worth while to consider if it is not possible to bring up the average result in some of the smaller states, where the load factor of central stations is low, to a somewhat higher basis of efficiency than now prevails.

The advantage of central stations of large size is, of course, well recognized; in fact, this greater efficiency of large stations is the main advantage that will probably follow from any co-ordination in super-power stations that may be achieved from the various projects now under consideration in various parts of the country.

Washington, D. C. R. S. McBRIDE.

Stokers and Fuel Oil

I am inclined to disagree with Mr. Daniels' views as expressed on page 684 of the April 27 issue of *Power*, and although I am neither an oil nor a stoker enthusiast, I can see where, in certain localities and with some classes of work, an oil-fired boiler is more desirable and efficient than a stoker-fired boiler.

In the first place his chart comparing the prices of coal and oil to give the same evaporation per dollar does not represent the true situation. Something else is neccessary to be considered, such as capital, labor and fixed charges, not to mention several other items of minor importance. Ignore capital and fixed charges, if you wish, and labor becomes a deciding factor. Figures and facts from stations operating with fuel oil show that if the labor charges in an oil-fired plant were as high as in a stokered station, fuel oil would be used only where coal is a luxury.

A 30-day test on the west coast shows a combined efficiency of 76 per cent or better with oil-fired boilers. I have not found such efficiency in any coal station up to the present. Why? In any equation the result is a function of the variables entering into it. With a seven-retort underfeed stoker there are at least seventeen variables: Seven upper and seven lower rams and coal, ash and air. The problem of the stoker operator is to change these variables to constants. This is nearly impossible as every operating man knows.

In an oil-fired installation, several variables are encountered: Temperature, moisture content, mechanical condition of the burner and air control. Temperature at which an oil atomizes best can be determined and remains fixed within a narrow range. Moisture is a factor of the condition as received and handled on its way to the burner, and can be controlled. The condition of the burner in operation is a matter of observation and can be detected very quickly. Air control is simply a question of using gas-analysis instruments. All these except one, moisture content, become constants at the hands of an experienced operator. Therefore, when the variables in stoker firing can be made constants, then and not until then can an equal efficiency be expected from a stoker-fired boiler as is being obtained in oil-fired plants today.

How many stoker boiler plants operate with one fireman and one watertender per 5,000 boiler horsepower? Under ideal conditions this might be possible, but not very probable. Many central stations are the result of several expansions from smaller stations. We must take conditions as we find them, not as they might be, and a labor analysis will show that most stations have four or five men per 5,000 boiler horsepower and could not operate economically with less.

Coal can be stored in a continuous pile, it is true, but even with the best of care spontaneous combustion and deterioration frequently take place, making it an expensive procedure and a constant source of loss. Fuel oil, on the other hand, does not deteriorate, and can be stored in tanks beneath the ground surface, requiring no expensive machinery in handling, with a capital outlay very little greater than that needed for coal storage of equal capacity. H. A. FOX.

Brooklyn, N. Y.

Lubricating Devices Neglected

While visiting a large number of power plants, I have been impressed with the lack of attention given to lubricating devices, particularly those on machinery outside the engine room. Usually, the sight-feed lubricator or oil pump on the main engine will be in good condition, with a clean sight-feed glass, tight packing, etc.; and the same applies, in general, to the oil cups or other means used for lubricating the bearings of the larger units in the plant. The reverse, however, is generally true of these devices when placed on pumps and other auxiliaries.

Of all the boiler-feed pumps I have ever examined, I do not believe one-third of them were equipped with lubricators that were in proper working order. The sight feed and gage glasses have almost always been filled with an oily residue resembling tar, and in many cases the wooden handles of the regulating valves have been broken or missing. If such a lubricator feeds any oil at all to the machine to which it is attached, it is only a matter of luck. There is no possible way of determining the quantity with any approach to accuracy, and scored cylinders, rods and packing are certain to result. Force-feed oilers on pumps are perhaps more often in working order, but even so, an obstructed sight glass frequently makes it impossible to tell the rate of feed.

Many makers place small glass oilers on the rocker bearings of large steam pumps, such as those used in elevator and fire service. In most cases that have come under my observation these oilers are allowed to become clogged with grease and dirt till they are useless. There is something particularly trying to see a large duplex pump pounding away with a full set of oil pumps and a lubricator, all with wide open feeds and yet not feeding one drop of oil to the protesting bearings. To my way of thinking it is often better to remove the oil cups, clean out the oil holes and lubricate at regular intervals by means of the good old squirt can.

Many apparently well-informed engineers seem to consider that rocker bearings, as opposed to revolving bearings, need but little lubrication. It is true that they do not need a great deal of oil, but they do need some, and they need it at regular intervals. I think it is nearly always safe to assume that the maker of a piece of machinery, whether it be a 2,000-hp. engine or a small steam pump, knows what parts need occasional oiling, and when he installs an oil cup or lubricator on the outfit it is the best plan to use it. HUGH G. BOUTELL

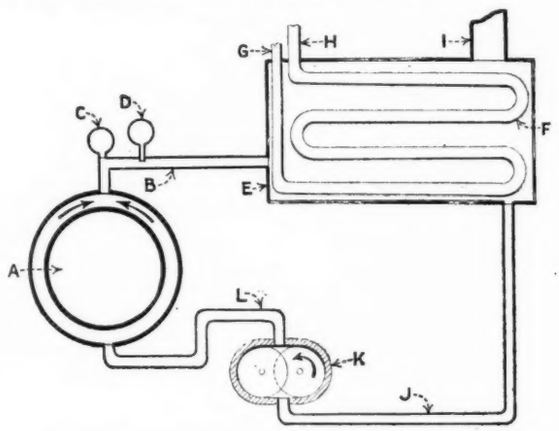
Washington, D. C.

Operating Diesel Engines

In the operation of Diesel engines I advise against overload as I find 90 per cent of the rated capacity of the general run of engines to be the maximum load that should be carried, even for a short period, and with some engines less than that. Most machines will do a little more than they are designed to do without injury, but there are exceptions to all rules and the internal-combustion engine is the exception.

Never let the cooling water leaving the engine get above 160 deg. F. I prefer to use a large amount of water and let it enter the engine at about 110 deg. F. and leave at about 140 deg., rather than to use a smaller amount of water at 70 deg. entering and 160 deg. leaving.

The cooler an engine is run the more fuel it uses per horsepower, but it amounts to very little. Running hot, with the water leaving at 200 deg. and above, will soon ruin the engine or seriously damage it. It is far better to spend a few cents more each day for fuel than to spend hundreds of dollars yearly for repairs.



CYLINDER-COOLING WATER SUPPLY SYSTEM

Attention should be given to the kind of cooling water used. Most domestic water contains too much scale-forming matter to be used for cooling Diesels. A $\frac{1}{8}$ in. thickness of scale has cracked many a cylinder head. I believe scale causes more damage to the oil engine than anything else.

I have found only one successful method of dealing with scale, which automatically allows the engine to cool off slowly and there is no danger of starting up, forgetting to turn on the cooling water, as has often been done, with serious results.

Referring to the illustration, *A* represents a single-cylinder engine; *B* is a cooling water line from the cylinder jacket and head; *C* is a thermostat that regulates the temperature of the water leaving the jacket by regulating the amount of cooling water going to the cooling coil *F;* it is also arranged to ring an electric bell in case this water should reach an unsafely high temperature. The recording thermometer *D* is to keep check on the cooling-water temperature.

The pure-water storage tank *E* contains enough cooling coils to keep the pure water at the required temperature; *F* is a cooling coil within the storage tank through which the cooling water passes, and *G* is the cooling-water supply line which is controlled by the thermostat *C*. *H* is a cooling-water line to the sewer or elsewhere, if so desired. *I* is a spout leading from the building roof drain and is to keep the storage tank *E* supplied with rainwater, and *J* is a suction line from the storage tank to the cooling-water circulating pump *K*, which should be of the double-gear rotary type, because it is simple and dependable. This pump should be extra large so as to run at a slow speed. *L* is a discharge line from the pump to the water jacket.

It can be seen that no scale trouble and cracked heads can result when using this system, if the tank *E* is kept supplied with rain or distilled water or any water that is free from scale-forming matter.

The cooling water necessary for the coils *F* will be a little more than if it was used directly on the engine jackets, but the differences in the cost is a slight matter compared with the trouble from scale that ordinary water would deposit in the cooling jackets and cylinder heads. The tank *E* should be closed to keep out dirt and to prevent the water from absorbing gases of the air, as well as to prevent the evaporation of the pure water. The line *I* should have a gooseneck water trap to prevent evaporation. The tank *E* should be extra large and should contain sufficient coils to cool the pure water to the required temperature. The rotary pump is driven by a silent chain from the engine camshaft.

This system, which is patented, works equally well on any type of engine, but it is preferable to have the circulating pump driven from the engine in some dependable manner, so that there will be no forgetting to turn on the cooling water. No valves should be put in any of the cooling-water lines to or from the engine; then there are no valves to forget. This system will do away with all scale troubles and allow the engine to automatically cool down gradually, as even after the pump stops some water will continue to circulate, owing to slipping of the pump and to the heating of the water in the jackets, which causes it to become lighter than the water in the tank. As the line from the jackets to the tank enters near the bottom of the tank, the water level should always be above this line.

If the coils *F* should scale up inside rapidly, a cooler of the atmospheric pipe type should be used instead of the coils in the tank. This cooler should be placed in the line *B* and the raw cooling water run over the piping, thus having the scale on the outside of the pipe.

The initial charge of water for the storage tank should be rain or distilled water, but if neither of these is convenient, the charge can be of raw water if such raw water contains less than four grains salt per gallon, because the little solid matter contained in one charge of raw water will make very little scale. Distilled water or raw water with less than four grains of salt can be obtained from most any ice plant, and after the first charge and if care is taken, the rains, as a rule, will keep the tank at all times supplied with fresh pure water.

I advise the use of plenty of lubricating oil in the cylinder and also the use of the same kind of oil on the bearings unless the latter are self-oiled. The bearing oil can be filtered and used over and over again.

Never run an engine overspeed in order to develop more power, because it is the same as overload, as the more power developed in a cylinder the more fuel is burned, and the more oil burned the hotter the cylinders get. Don't get them hot!

To sum it all up, don't overload, don't overspeed, and keep the engine cool and well oiled.

Winkelman, Ore. GEORGE J. TROSPER.

Electric-Arc Versus Gas Welds

Mr. Perry's article, page 604 of the April 13 issue of *Power*, would seem to the casual reader to force the conclusion that electric arc welding is per se better than oxyacetylene, and that oxyacetylene welds are in fact dangerous. I cannot too strongly oppose such a conclusion, because it is not in accord with the facts.

Mr. Perry, like many others, has had unpleasant experiences with oxyacetylene welding; others than Mr. Perry have had equally unpleasant experiences with arc welding. The fact is that in no case will satisfactory results be had unless the metal is thoroughly fused, and lack of fusion is just as liable to occur in one process as in the other, unless the operator is competent and careful. I have critically examined hundreds of welds made by many welders, and the foregoing statement is made as the result of these examinations.

In one series of tests of arc welds the tensile strengths ran from 18,000 to 65,000 lb. per sq.in. The tests were made by unbiased authorities, and an examination of the fractures showed wide variations in the qualities of the welds, which accounted largely for the great differences in the test results. I have seen and have carefully examined welds made by all the manufacturers of arc-welding apparatus. I have seen many operators do their work and have found from the same apparatus, good and bad results. This is true of the machine to which Mr. Perry refers as well as the others. But this should not prejudice anyone against any machine, because it is well known that good work is done with all machines. I have also seen many incompetent oxyacetylene operators and know that plenty of bad oxyacetylene welding is done. But these facts cannot be fairly used as an indictment of the process. Really there are some things that can be better welded by one process than by the other; and I use both processes in my shop, and could not well afford to be without either; so I feel that I cannot be accused of being prejudiced.

Further, I will guarantee to do either of the jobs mentioned by Mr. Perry with entirely satisfactory results by the oxyacetylene process, though it is entirely possible that for various reasons he would choose arc welding if the work were done in his shop.

Mr. Perry makes the sweeping statement in the latter part of his article that arc welding is superior in the case of a number of metals, among which are cast iron, bronze and monel metal. I would be glad to get samples of these welds for examination, because I have been told by many who are competent to judge, that arc welding of metals referred to is not satisfactory.

I know of no job shop, and job shops have to guarantee their work, that would take a chance on electric arc welding a press frame or any other piece in which the full strength of the section has to be developed, though such pieces are welded by the oxyacetylene process in many shops with entire satisfaction. It is necessary, in such a discussion as this, to be sure that the bases of argument are thoroughly understood.

In welding copper alloys, such as brass and bronze, much depends on their composition, and much on the physical structure where the composition is the same. For example, 60-40 brass is much easier to weld and gives better results than 70-30; and gun metal, 90 parts copper and 10 parts tin, welds much more satisfactorily when the delta constituent is absent, as it is in rather large or rather slowly cooled castings. It is also a fact that many brasses and bronzes are unweldable if anything approaching the original structure and composition is desired. I have had many problems of this kind to solve and in most cases have been unable to meet the requirements. For example, repairing gun-metal castings is impossible, if soundness, color and full strength are essential, though many such castings have been welded in my shop, with acceptable results; the color of the welds was different, and the strength of the joint was less than that of the original material.

I recall two large gun-metal castings, weighing over three thousand pounds, and of very complicated design, which were successfully welded as proved by satisfactory results in service. But chemical analyses and microscopic examinations were made before the work was started, the welding material was specially made for the purpose, and the preheating was regulated with a pyrometer.

This subject might be much enlarged on, but I feel that I have said enough to cause the casual reader to be chary about accepting any general statement as to the superiority of one welding process over another.

S. W. MILLER,
Rochester, N. Y. Rochester Welding Works.

Keeping Out of the Rut

In an experience of several years in plants ranging from a few hundred to over twenty thousand horsepower, as assistant and chief, I have found conditions as Mr. Duffy enumerates them in his communication, "Keeping Out of the Rut," page 602, April 13 issue.

This game of being "Chief," whether in name or in fact, is not always the "feet on the desk" job that a casual observer might remark, and a man in the business should thoroughly appreciate this fact. It is an easy and not uncommon thing to criticize the man higher up, and it may look to the assistant who works eight hours and then forgets the plant for the next sixteen, as though his chief were in a rut, when as a matter of fact the chief may be entirely out of it and hitting it up on high.

A little example of this "in the rut" dope came to light in a plant with which I am somewhat conversant. The watch engineers used to get together while changing shifts and talk over "the chief." They thought he was "in a rut" because he insisted on the regular routine of work being carried out to the letter. He had true and tried ways of doing things, and the wheels never had failed to turn on schedule.

A new addition was contemplated and modern machinery was to be installed, and the watch engineers decided that they must tell the chief (who was a bit old-fashioned) that the new feed pumps should not be the old plunger type, but of the more modern centrifugal type. So they waited on him and presented their ideas. He took out an order book and showed them an order for the same design of pump they had suggested.

My advice would be to the assistant who thinks the "chief" is in the rut, to keep out of the rut himself and run by if possible, but to be very sure that the chief is in the rut before trying a marathon. I have always had an antipathy to criticizing the man higher up, and if he was "in the rut" I was generally far enough behind so that his position did not retard me.

New York City. C. W. PETERS.

INQUIRIES OF GENERAL INTEREST

Steam Laps of D Slide Valve—If the length of a D slide valve is 25⅝ in. and the distance between the outside edges of the steam ports is 24 in., how much is the steam lap of the valve? P. S. L.

The sum of the steam laps of each end of the valve would be 25⅝ — 24 = 1⅝ in., and when the laps are equal, each lap would be half of 1⅝, or ⅞ in.

Advantage of Inclining Hand-Fired Grate—For a hand-fired boiler, what is the advantage of having the rear end of the grate lower than the front end? J. A. A.

The draft is stronger in the rear end of the ashpit, and with even firing a thicker fire becomes built up at the rear end of the grate; and having the grate pitched toward the rear end makes slicing and firing easier.

Cause of Pump Becoming Airbound—What causes a pump to become airbound, and how can the trouble be remedied? S. P.

Under atmospheric conditions water contains about 2 per cent air in solution. When subjected to less pressure the air expands, and when given sufficient time, as while the water is flowing through a long suction pipe, the air becomes liberated from the water, usually in the form of collections of small bubbles that adhere to the pipe or pump surfaces, or the air gathers in pockets of the pump spaces. The trouble can be prevented by increasing the head of the suction supply and by running the pump slower, so the pump cylinder will be filled with less reduction of pressure of the suction water.

Pressure Values Given in Steam Tables—Why are not steam tables arranged to show temperatures and total heat of steam for each pound of gage pressure instead of absolute pressures? W. D. P.

The temperature and heat per pound (weight) of dry saturated steam depends on the absolute pressure, while gage pressure is the pressure above atmospheric pressure, which is variable with the elevation of the place and also varies with changes of atmospheric conditions. Therefore steam tables based on gage pressure would need to be adapted to a particular pressure of the atmosphere, and greater convenience in their use would be confined to cases where the atmospheric pressure was the same as that for which the tables were particularly constructed.

Pressure at Discharge Coupling of Sinking Pump—What is the pressure on the pump couplings of a 3-in. rubber-lined hose, delivering 100 gal. of water per minute from a mine sinking pump against a head of 275 ft? S. A. M.

Water pressure due to a head of 275 ft. would be equivalent to 275 × 0.433 = 119 lb. per sq.in., and for raising the water the pressure discharged into the lower end of the discharge line will be that pressure plus the pressure required for overcoming friction plus an excess pressure due to pulsation of the pump. The pressure required for overcoming friction to discharge through hose depends on the kind and roughness of the lining, freedom from kinks or short bends, the length of the hose and the rate of discharge. For smoothest surface of rubber lining and straight hose, discharging at the rate of 100 gal. per min., the frictional resistance will amount to only about one pound per sq.in. per 100-ft. length of hose. The pressure due to pump pulsations depends on the number of piston reversals per minute and the smoothness of operation of the pump. The pressure effect of such impacts cannot be computed, but under ordinary conditions would not exceed 20 lb. per sq.in. With delivery at the rate of 100 gal. per min. through 300 ft. of straight 3-in. smooth-lined rubber discharge hose, the maximum pressure at the pump coupling would be about 142 lb. per sq.in., but with a kinked or rough-lined hose there would be a rapid increase of frictional resistance and of total pressure required to effect a stated rate of discharge.

Revolutions of Pump—What is meant by the number of revolutions per minute of a direct steam pump? W. R.

A revolution signifies a complete cycle of the reciprocating parts, and the number of revolutions per minute would be the number of repetitions of movement of any moving part, as one of the crossheads of a duplex pump. The term is more specific for designating the number of piston reversals than "strokes," for in a single pump the term stroke is sometimes confused with double stroke, and in a duplex pump it is frequently doubtful as to what is meant by the number of strokes per minute. With the type of pump and number of revolutions given there is no ambiguity as to the number of single strokes.

Size of Synchronous Motor—In our plant the present maximum load amounts to about 325 kw. At this load the power factor is around 0.72. We are putting in some additional equipment to be driven from a lineshaft, and from what can be determined from some of our other drives, 78 hp. will be required to drive the new installations. I would like to know the size of synchronous motor to install to drive the load and also raise the power factor to 0.90. M.A.B.

Synchronous motors usually are rated in kilovolt-amperes, therefore in this problem the motor will be rated in kva. The mechanical load on the motor will be 78 hp. or (78 × 746) ÷ 1,000 = 58 kilowatts. This makes the total kilowatt load equal to 325 + 58 = 383. The kilovolt-ampere load equals kilowatts divided by power factor; therefore, in the first case kva. = 325 ÷ 0.72 = 452, and in the second, kva. = 383 ÷ 0.90 = 426. Wattless component, $WC = \sqrt{\text{kva.}^2 - \text{kw.}^2}$; then, with the present load $WC = \sqrt{452^2 - 325^2} = 314$, and with the synchronous motor added $WC' = \sqrt{426^2 - 383^2} = 186$ kva. The difference between WC and WC', or 314 — 186 = 128 kva., represents the leading wattless component that must be supplied by the synchronous motor, in addition to doing 58 kw. of mechanical work. Then the total motor capacity required is equal to the square root of the sum of the squares of the two loads, or $\sqrt{128^2 + 58^2} = 140$ kva., and the power factor of the motor equals kilowatts divided by kilovolt-amperes = 58 ÷ 140 = 0.41. It will be seen from the foregoing that by installing a 140-kva. synchronous motor and operating it at 0.41 power factor leading, it will do 78 hp. of mechanical work and raise the power factor of the total load to 0.90, and the kilovolt-ampere load on the generators will be reduced from 452 to 426 kilovolt-amperes; besides, under the new condition the voltage regulation will be improved.

Utility Men Discuss Pressing Problems at N.E.L.A. Pasadena Convention

A POWER demand far exceeding the available supply; how to meet this demand under existing conditions of the money market; shortage of materials, fuel and labor; ability to maintain service with greatly overtaxed equipment; and the necessity for flexible utility regulation to compensate for such conditions, were the main subjects discussed by the twenty-two hundred delegates to the forty-third convention of the National Electric Light Association at Pasadena, Cal. The power shortage is not local to any section, but is nation wide, although the condition has been rendered more acute in California by an unusually dry season and a gradual depletion of the oil fields, resulting in soaring prices for fuel oil, with a consequent turning to hydro-electric power.

President Ballard Opens the Convention

In opening the convention, President R. H. Ballard estimated that there is needed $750,000,000 of new capital to take care of the expanded requirements of the country; and the ability to raise this sum depends on the earning power of the investment, favorable opinion of the public at large, and the extent to which the utilities are forced to compete in the money market. As a substantial aid to financing new developments, he believed that the public should be fairly and fully informed as to the status of the industry and its possibilities for general public service. Moreover, the kind of public ownership that brings results is ownership by the public at large in the stocks and bonds of their local regulated utility companies.

Governor Stevens Welcomes the Delegates

Governor W. D. Stevens, in welcoming the delegates, referred to the fact that California, although richly endowed with water power, has been denied coal fields, and its once vast oil resources are now being drawn upon to the extent that they are rapidly approaching depletion; therefore the future must look to further water-power development to meet the growing needs of agriculture, transportation and, eventually, he hoped, manufacturing. There has already been developed in the state over 900,000 hp., and an additional 180,000 hp. is now under construction; but it would be possible to develop five times this amount. With perhaps one exception, California has the largest per capita use of electricity of any state in the Union, and the present problem is not one of demand but of supply.

Mr. Edgerton's Address

The most constructive address of the convention was delivered by E. O. Edgerton, president of the California Railroad Commission. "The interest of the public is paramount," he said, "but what is good for the public is also good for the utility, and it is to the interest of the public that these utilities be kept sound." He depreciated statements that public-utility securities are in general unsound, and believed that investment can be attracted where there is proper regulation. The asset of a utility is essential service, and the regulating commission holds that asset in trust. He believed that too much time is ordinarily wasted on methods of valuation; they get nowhere and befog the issue. Instead the situation should be faced squarely, starting first with sound capitalization, then fixing rates necessary to induce and support that capitalization, plus necessary reserve. Having thus taken care of the investor, the next and very important duty is to reward efficiency within the organization from the president down to the office boy, by both remuneration and advancement wherever possible. The regulating body should see to this, for it is the greatest factor in securing service. Too often, in the opinion of the speaker, increased wages had been given only to the organized because of threats and the unorganized were overlooked. "There is no better way," he said, "to take men out of the control of demagogue leaders than to insure a reward for efficiency."

M. S. Sloan, president of the Brooklyn Edison Co., in reporting on "The Electrical Resources of the Nation," called attention to the fact that the Government, although periodically making a rather incomplete survey of central-station and railway power, had neglected to make a study of isolated plants and in no case had gone into the subject of transmission capacity, diversity factor, etc., all of which is essential to a thorough study of the question. This matter had been taken up with the Council of National Defense, and it is possible that something may be done.

The Committee on Water-Power Development, of which Franklin T. Griffith is chairman, presented an exhaustive report which reviewed the existing Federal and state laws as applying to the use of water power on public lands and navigable streams, and expressed the opinion that the water-power bill now pending in Congress, would, if passed, do much to promote early development.

Over 68 per cent of the potential maximum horsepower of the United States lies in the Western States and nearly 75 per cent of the total comes under Federal jurisdiction. In the New England states 77 per cent of the potential water power has been developed and little additional development may be expected in this section. Future development will consist in the more efficient utilization of that already developed.

Water power in the West, in the main, has not followed the popular conception of such enterprises, the typical Western development uses no waterfall of any volume; instead, the project is usually located in a mountain canyon where either a reliable minimum flow of the stream may be found the year round or else storage is developed above the point of diversion.

Among the records which typify the magnitude of western development may be mentioned the following:

Hydro-Electric Generation Projects

The largest single discharge turbine in the world: 20,000-hp.—Wise Power Plant, near Auburn, Cal.; Pacific Gas & Electric Co. The most powerful high-head turbine in the world: 23,800-hp.—White-River Plant, near Seattle, Wash.; Puget Sound Power & Light Co. A unit of practically similar size is installed in the Long-Lake Plant, near Spokane, Wash.; Washington Water Power Co. Other large units: Southern California Edison Co. is installing two 22,500-hp., 800-ft. head Francis reaction-type turbines in its Kern River No. 3, while the Great Western Power Co. will install impulse wheels under 1,008-ft. head at its Caribou plant on the Feather River with capacity of 30,000 horsepower.

The highest head plant in America: The San Joaquin Light and Power Corporation plans two units under 2,500-ft. heads in connection with its King-River project, already begun, and a similar head is contemplated by the Southern California Edison Co. in the Big-Creek development. Typical also of western construction is the 17-ft. section tunnel being driven by the San Joaquin Light and Power Corp. to serve its Kerckhoff plant, a world's record in dimensions for hydro-electric tunnels, a steam shovel being used in mucking inside the tunnel.

High-Voltage Transmission Lines

First long-distance transmission: 20 miles at 10,000 volts from San Antonio to San Bernardino, Cal. Longest high-voltage transmission: 87,000 volts and 55,000 volts, 539 miles, from Mono County, Cal., to Yuma, Arizona; Southern Sierras Power Company.

Highest voltage transmission: Present record, 150,000 volts, 240 miles, Big Creek to Los Angeles; Southern California Edison Co. The Great Western Power Co. is now installing a 165,000-volt line from its Caribou plant to San Francisco. The Pacific Gas & Electric Co. has in contemplation the building of a 220,000-volt line from its Pit River plant into San Francisco, while other western

companies are planning 220,000-volt lines for the near future.

The power consumed in the various sections of the country is given in the following tabulation:

District	Population	Millions kw.-hr.	Million dollars gross rev.	Kw. hr. per capita	Cost per kw.-hr.	Revenue per capita
New England	9,448,000	2,398.6	64.47	254	$0.0293	$ 6.82
Atlantic	36,798,000	13,340.5	304.71	363	0.0228	8.24
Central	54,222,000	14,688.1	299.02	271	0.0204	5.52
Western	9,375,000	6,307.5	104.80	673	0.0166	11.17
Total	109,843,000	36,734.7	773.00	334	0.01212	7.05

From this it will be seen that the per capita use of electricity in the Far Western States is 2.21 times that of the remainder of the nation. On the other hand, the average rates for electricity in this section are low—1.66c. per kw.-hr. compared with 2.19c. obtaining elsewhere.

Prime Movers Discussed

Of particular interest to the operating men was the report of the Prime-Movers Committee* a brief résumé of which is here given.

Improvement in Turbine Design

A record of the units that have been installed during the past year indicates that 30,000 kw. 1,800 r.p.m. 60 cycle, and 35,000 kw. 1,500 r.p.m. 25 cycle can be considered for the present as the maximum standard size of single-shaft single-barrel units.

*An abstract from the part of this report pertaining to steam turbines was published in June 1 issue; other parts pertinent to the power field will be abstracted and published in another issue.

The present is a period of adjustment and improvement, and manufacturers are devoting their attention to modification of design features with a view to securing a requisite degree of reliability and operating efficiency.

The increase in both the diameter and speed of rotating elements makes the subject of turbine balancing one of particular interest at present. Dynamic-balancing machines which determine with extreme accuracy the amount of unbalance in a turbine rotor or other apparatus are now in general use.

The alternate stressing to which turbine wheels and blading are subjected brings up the question of fatigue of metals, a subject which is being thoroughly investigated by the Engineering Division of the National-Research Council. The results of these tests are expected to be extremely valuable to both turbine designers and operators.

Investigations made by shipbuilding companies into the causes of pitting and erosion of gears, have disclosed facts which may explain some of the gear troubles experienced by operators of stationary plants.

Structure of Condenser Tubes

The examination of the structure of condenser tubes by microphotography is important, in that it gives data on the relation between the microstructure and the life of condenser tubes.

The maintenance of high vacuum and the possibilities of condensing equipment in relation to possible theoretical vacuums are still receiving close attention by plant operators.

Boilers and Superheaters

The tendency toward large-sized units has continued during the past year. Units of 1,000 to 1,500 hp. and over are quite common in central-station practice.

On boilers made under war and post-war conditions troubles have developed due to faulty shop work, and it is the desire of the committee to sound a note of warning in this respect.

The Uniform Boiler-Law Society reports that nineteen states and a large number of county and municipal bodies have adopted the code to date.

Manufacturers report no radical changes in design features but their statements do indicate a general tendency to turn out boilers of higher-rated capacity, without increasing materially the maximum pressures now in general use.

Trend Toward Steel-Tube Economizers

The trend, as indicated by recent installations, appears to be toward the steel-tube economizer, showing confidence on the part of engineers that corrosion troubles can be eliminated by the exercise of reasonable care.

The economic value of economizer surface and the amount to be installed in any given plant can be determined only by a detailed analysis of operating conditions and a thorough study of complete plant designs. No formula can be devised for obtaining a solution, but it is possible to indicate in a general way the method of attacking the problem.

Grate and Stoker Design

Statements by manufacturers indicate that there have been no radical changes in stoker design, but that efforts have been along the lines of perfecting new devices reported last year, and to a refinement of operating details.

There is a tendency among designing engineers to lay out the stoker and the furnace so it will be readily possible to change over from coal to oil, using one or the other, depending on the fuel-price differential.

Burning Sub-Bituminous Coals

With lignite and sub-bituminous coals, hand-fired grates seldom give boiler ratings over 100 per cent; efficiencies are usually below 60 per cent. Using mechanical stokers, outputs from 200 to 300 per cent are sometimes possible, with efficiencies ranging up to 70 per cent. Combustion rates as high as 35 lb. per hr. per sq.ft. of chain-grate area, and with underfeed stokers over 1,000 lb. per hr. per retort, have been reported.

Growing Interest in Pulverized Fuel

There has been a rapidly growing interest in the development of pulverized-fuel equipment, and a large number of installations of this character have been placed in operation.

The number of manufacturers supplying apparatus for pulverized-fuel installations has also increased. Statements submitted by these companies indicate that their efforts are being directed toward the perfection of the details of equipment for pulverizing, drying and transportation of the fuel.

One of the questions which has been passed over too lightly by both manufacturers and users of this equipment, is that of the ultimate disposal of the ashes which now pass out the stack. If the use of pulverized fuel is extended, municipalities will undoubtedly pass ordinances to eliminate the ash nuisance.

Increasing Demand for Fuel Oil

Figures of oil production and consumption for the past year indicate that the United States is becoming more and more dependent on imports of oil to meet the rapidly increasing demand.

The requirements of oil-burning ships and the improvement in the processes for converting heavy oils into gasoline are responsible for the diminished supply and poor quality of the oil available for general use as fuel.

The tendency of oil supply companies is to fix the price of oil at what the traffic will bear without any particular reference to the cost of production. For this reason it is difficult to see how an adequate supply of fuel oil at reasonable prices can become available for central stations, until imports of oil from Mexico reach such proportions as to occasion a sharp decline in the market price.

Power-Station Auxiliaries

An investigation of total evaporation per kilowatt-hour of gross generation revealed the fact that load factor and other special considerations are given more weight than the strict adherence to the method of maintaining heat balance. In this connection it should also be noted that maximum over-all efficiency rather than individual machine efficiency is the object sought in station operation. To realize best over-all efficiency, it may be necessary to depart from hard and fast rules.

Observation by committee members indicates the need of more liberality in specifying the capacity and performance of auxiliary equipment, as well as the desirability of more frequent testing of steam-driven auxiliaries.

Boiler and Turbine-Room Instruments

The past year showed increasing use and interest in indicating and recording instruments. The wider use of these devices has been justified by the savings realized since their introduction.

Among the more important points brought out by the committee's investigation are the need of a reliable and reasonably cheap pyrometer, the adoption by some companies of meters on boiler blow-down lines, and the substitution of self-starting synchronous motors in place of clock mechanisms for instrument drive.

Higher Steam Pressure

Practically all equipment manufacturers agree that the problems encountered in the use of high-pressure steam

can be solved, and it is suggested that a trial installation might be made by equipping an existing station with a comparatively small high-pressure boiler and turbine, the latter so designed as to discharge into the main steam header of the station. Such a method would show up troubles with valves and piping and would furnish a great deal of data at comparatively small expense.

Improvements in Oil Engines

Improvements in Diesel-engine design have resulted in an engine far better than those built a few years ago. Small engines are principally four-cycle multi-cylinder high-speed units, while in the large sizes the trend is toward two-cycle units. Fuel consumption is not capable of much further reduction, but engines are being adapted to use lower grades of fuel. The necessity for high-grade attendance is being recognized more than ever before by owners.

Development of Hydraulic Prime Movers

The large number of hydro-electric units installed throughout the United States, with high over-all efficiency and almost perfect continuity factor, and the development of a new type of high-speed runner are the outstanding features for the year.

Automatic hydro-electric plants are receiving favorable consideration, and there is a tendency to confine the power-station building to housing only the generating and control equipment

Where climatic conditions are favorable there is an even more radical tendency to have the generating equipment outdoors, housing only the control apparatus.

Manufacturers' statements indicate a trend toward larger units and toward the consolidation of small water-power projects into single stations of large capacity.

Hydraulic Stations and Steam Plants

The combined operation of hydro-electric and steam plants presents many operating problems which should be worked out for the best interests of both parties, or to secure minimum over-all cost. Unnecessary steam generation should be eliminated as far as possible to secure the maximum hydraulic output consistent with minimum steam cost, including maintenance. Increased costs of construction and of fuel and increase in load make it particularly important to secure the maximum useful work out of every pound of water that can be used for power generation at the hydraulic plant.

In discussing the report, E. E. Gilbert of the General Electric Co. expressed the opinion that in future designs it would not be necessary to sacrifice economy for reliability. E. H. Sniffin, of the Westinghouse company, agreed with the committee's statement as to limitations in the size of single-shaft, single-barrel units. He was inclined to disagree, however, with the opinion that the oil temperature should be held to 140 deg. and believed that 160 deg. would be better practice; if 140 deg. were held to, the oil should be of lower viscosity. Referring to turbine piping, he believed that too little attention is given to insure flexibility, as the front end of the turbine works in all directions and the piping should allow for this.

F. T. Webster, of the Allis-Chalmers Co., said that his company had been conservative as to turbine sizes.

Considerable discussion developed on hydro-electric operating practice in the West, in which it was brought out that conditions of load in that section do not necessitate holding so strictly to frequency as in the East where manufacturing loads are supplied and speed is an important factor in production. For instance, the Southern California Edison, which normally operates on fifty cycles, has recently dropped to 47½ cycles to conserve water in certain cases where two plants are in parallel. According to H. A. Barre, of this company, its supply is divided into three classes: Base water power, reservoir plants, and steam plants. Under normal conditions both the base and reservoir plants carry the base load and the steam plants the peaks. During the present dry season, however, this practice has been reversed, but the economy has not been as great, owing largely to the fact that it has been necessary to keep in service many of the older and less efficient steam units.

S. J. Lisberger, of the Pacific Gas and Electric Co., stated that one of the greatest difficulties encountered when running steam plants in parallel with water-power plants is to hold the steam unit on the line when a short-circuit occurs on the system. To avoid this, they had set the governors to 12 per cent over-speed in spite of protests from the manufacturers. With their oil-burning plants and steam turbines floating on the line, it was possible to pick up a load from 1,000 to 20,000 kw. almost momentarily without even a perceptible flicker in the lights.

Fuel-Oil Discussion

Dr. J. S. Jacobus, advisory engineer, Babcock & Wilcox Co., stated that long experience had shown steam atomizing of fuel oil to give good results up to about 200 per cent of the boiler rating, but above this mechanical atomization is best because combustion is more rapid, giving the available combustion volume of the furnace better opportunity to function at greatest advantage. Mechanical burners naturally require more draft to give the higher capacities, and for ratings above 200 per cent a forced blast at the burner is used. The Babcock & Wilcox Co. is now delivering boilers 26 tubes high of 150,000-lb. steam per hour capacity; the high boiler, the Doctor said, is showing higher efficiency than wide, low types.

Cast-iron economizers should not exceed 75 per cent of the boiler surface. Wrought steel is now extensively used for economizers. The cause of interior corrosion in economizers is usually the air or oxygen present in the feed water. To preserve the exterior surface against corrosion keep the feed-water temperature above 120 deg. F.

C. R. Weymouth, chief engineer, Charles C. Moore & Co., San Francisco, stated that boiler and furnace maintenance is less with oil than with coal as usually fired. He cautioned against preheating the oil too much, a practice which he intimated was becoming general. Steam atomization is the usual practice on the Pacific Coast, though some mechanical atomization plants will soon be in operation. Self-cleaning oil strainers form an important part of the equipment, for if the oil contains silt, even in small quantities, the burners are rapidly eroded. Mr. Weymouth laid emphasis upon the economy of automatic as against hand control in oil burning, pointing out that steam consumption for atomization was but 1 to 1½ per cent with the former, and 2 to 3 per cent in well-conducted plants for the latter.

In view of the volume of work in connection with the preparation of the Prime Movers Report and of the increased attention to water-power operation, it was decided to divorce water power from the Prime-Movers Committee and put it in the hands of a separate committee for the ensuing year.

A very important suggestion was made by Chairman N. A. Carle, and adopted by the section, to have the Prime-Movers Committee prepare an operating code for central stations. Moreover, in view of the reconstruction period and the reorganization of the association the personnel of the committee and subcommittees of the Technical and Hydro-electric Section agreed to serve for another year.

New Officers of Association

The officers for following year are: President, Martin J. Insull, vice-president, Middle West Utilities Co., Chicago, Ill.; vice-presidents, M. R. Bump, chief engineer, Henry L. Doherty & Co., New York; F. W. Smith, vice-president and general manager, United Electric Light and Power Co., New York; H. W. Johnson, vice-president, Philadelphia Electric Co., Philadelphia, Pa.; Franklin T. Griffith, president, Portland Railway, Light and Power Co., Portland, Ore.; treasurer, H. C. Abell, vice-president and engineer, American Light and Traction Co., New York City.

Entertainment Features

California's welcome to the N. E. L. A. and its open-hearted hospitality left nothing to be desired. Everyone felt that the time spent in the land of sunshine was all too short. Automobiles were always at hand to answer every wish to explore the surrounding country. No state has more to display in attractive scenery reached by excellent roads.

At San Bernardino delegates were greeted by a live reception committee of young men and women. Their baskets of oranges were soon exhausted. At Riverside autos were ready to take delegates through the orange groves and

to the hills overlooking the surrounding country. Pasadena, not to be outdone, welcomed the Red Special with a Cowboy Band, a stage coach and riders. A hold-up by the Indians and the rescue of Smith, Sloan and Johnson by cowboys were enjoyable features of the trip to the Huntington Hotel.

Every hour of the day and night was filled with entertainment features. The formal opening of the convention came Tuesday evening with the President's reception and ball, followed by an electrical display and special dances on the lawn of the Hotel Huntington. Golf courses were visited by large numbers of delegates. Wednesday afternoon a special automobile trip was made to Los Angeles, where delegates and friends were the guests of the Universal City. A special motion picture was put on to show the great part which electric lighting plays in this work. Before leaving on this trip the guests were assembled on the Huntington lawn and a moving picture was taken, which was shown at a convention meeting Thursday evening.

Another feature in moving pictures was "That Fairy in the Snow-Flake," prepared by the Westinghouse company, and telling the story of water-power development.

An entertainment feature that appealed especially to delegates from the East was the Mission Play at San Gabriel. Special cars were provided to take all who wished to see this famous play and in this way hear the story of California told on the very ground where one of the missions still stands.

Trips to power plants, parties to well-known points, excursions to beaches, mountain resorts, fruit-packing houses, kept delegates so busy and preoccupied that the convention week passed all too quickly.

The La Fiesta Electrica closed the entertainment features in a blaze of glory.

Sundry Civil Bill

In commenting on the super-power item in the Sundry Civil Bill, Dr. George Otis Smith, the director of the Geological Survey, who will have charge of the work, said:

In these days of economizing in government appropriations it is refreshing to note some of the remarks on the floor of the House by Representative Good, of Iowa, chairman of the Sundry Civil Appropriations Committee, and Representative Byrns, of Tennessee, ranking minority member of that committee, in which they urged additions to appropriations. Their arguments were in defense of an item of $125,000 providing for an engineering investigation by the United States Geological Survey of the super-power project for the eastern United States.

Mr. Byrns stated that "this proposition is one that looks forward to the conservation of our resources and, as has been stated, the time is at hand when something must be done looking to the conservation of our fuel supply because those in authority state that at present the known supply of oil will be exhausted within a very few years at the present rate of consumption." He further characterized this Geological Survey investigation as one that should be made "by Government experts in order that if the investigation discloses that such a plan is practicable, those who are asked to make those investments will have confidence in the accuracy and impartiality of the report."

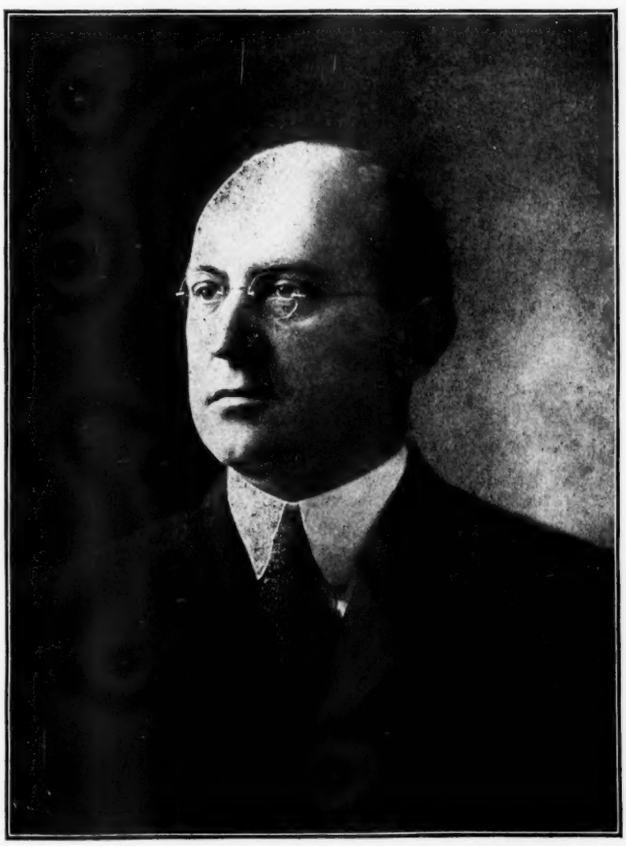
Chairman Good in reporting the Sundry Civil Bill had already made special reference to the super-power item in the bill as unique, but, as he believed, vitally important, and he stated that such a survey would represent "Government initiative and co-operation which will result in the savings to the country of hundreds of millions of dollars annually. It will result in a great saving in the direct cost of fuel. It will furnish a reserve source of power for transportation and utility companies which will be of large value in time of labor disputes and public emergencies. The principle can be applied broadly. Its benefits will accrue to towns and villages and to the farms of the country." Chairman Good also stated that this provision best illustrated the policy of including in the appropriation bill items providing for the future. He said: "Government cannot stand still. It must advance. It must provide for healthy growth of every useful governmental activity."

In concluding the debate on this item, which was followed by a favorable vote, Chairman Good remarked: "We may smile at this proposition. We may laugh it out of Congress just as we did by ridicule the proposition of Mr. Langley in regard to the airplane."

To those who are interested in scientific and engineering investigations under Government auspices such expressions by leaders in Congress are encouraging. It is also worthy of note that neither Mr. Good nor Mr. Byrns represents sections of the country that would primarily and immediately be affected by the proposed investigation. They seem to represent the country as a whole.

Russell H. Ballard, Past President, N. E. L. A.

Russell H. Ballard, president of the National Electric Light Association during the past year, was superseded by Martin Insull, former vice president of the association, at the election held in Pasadena, California, Friday, May 21. Mr. Ballard was born in Hamilton, Ontario, in 1875.



RUSSELL H. BALLARD

When fifteen years of age, he obtained his first position with the Thomson-Houston Electric Co., Chicago, Ill. He went to Schenectady in 1894 when the Thomson-Houston Co. consolidated with the General Electrical Co. He remained there until 1897, when he became associated with the West Side Lighting Co., now the Edison Co., at Los Angeles, as bookkeeper. Later, he served as cashier and office manager of the Butte (Montana) Electric and Power Co. He became auditor of the predecessor of the Southern California Edison Co. and was soon made first vice president and general manager and soon became a leading figure in Pacific Coast utility work.

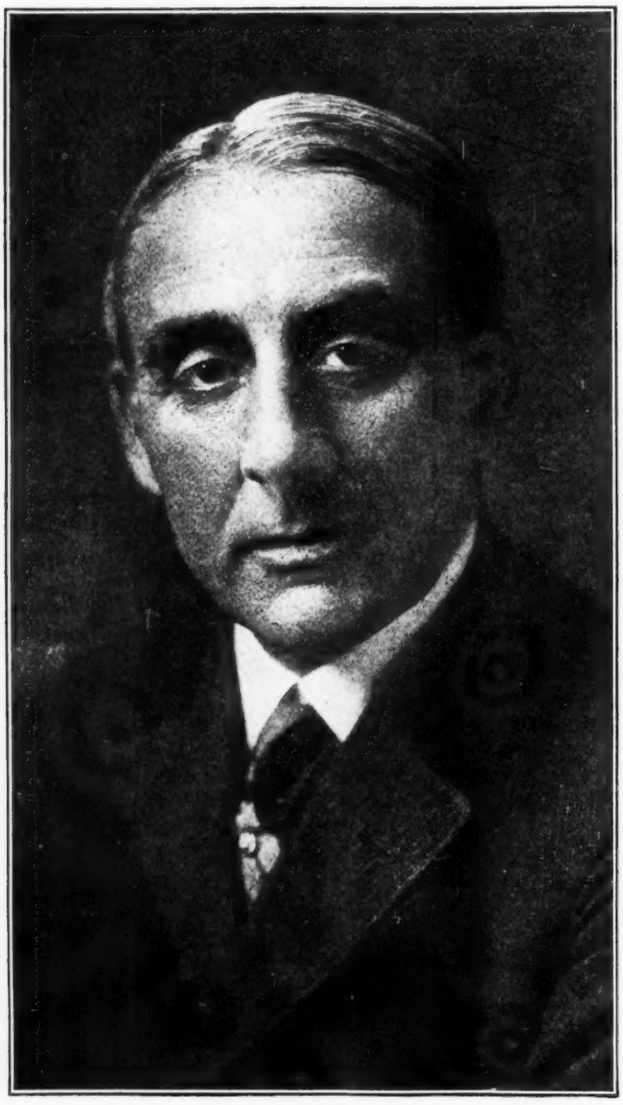
Mr. Ballard was the first president of the Pacific Coast Section of the N. E. L. A., where he figured prominently in the activities of the organization. During the past year, as president of the organization, much of his time has been taken up with the comprehensive plan of reorganization which was brought to the attention of the delegates at the convention.

Martin Insull, President, N. E. L. A.

Martin Insull, vice president of the Midwest Utilities Co., Chicago, and during the past year first vice president of the National Electric Light Association, was elected president at the convention held in Pasadena, California, on Friday, May 21. Mr. Insull will replace Russell H. Ballard as president.

Martin J. Insull was born in Reading, England, and received his early education in that country. He was engaged in the manufacturing end of the telephone industry before coming to this country, in 1887.

Almost immediately he entered the shops of the Edison Machine Works at Schenectady, N. Y., then a very small



MARTIN INSULL

concern, comparatively speaking, and was employed there until he entered Cornell University in 1889.

Being graduated in 1893, Mr. Insull became a member of the firm of Sargent and Lundy, prominent Chicago engineers, continuing that connection until 1898, when he entered the electrical manufacturing business as vice-president and general manager of the General Incandescent Arc Light Co. in New York City. In 1903 that company was acquired by the General Electric Co., and a few months later, in 1904, Mr. Insull was appointed a vice-president of the Stanley G. I. Electric Co. and removed from Pittsfield, Mass., where he had been sent following the acquisition of the General Incandescent Arc Light Co. by the General Electric Co., to Chicago. There he had charge of the Western business of the Stanley G. I. Electric Co. until 1906, when he entered the field of public service operation.

During the next six years Mr. Insull had charge of and operated electric light, gas and traction companies in southern Indiana. Upon the absorption of these companies by the Middle West Utilities Co. of Chicago, in 1912, Mr. Insull was made senior vice-president, in charge of operations, of the Middle West Utilities Co. in Chicago, where he is now located. The Middle West Utilities Co. is a holding company controlling thirty subsidiary companies which serve 485 communities in fifteen states. These companies have a gross income of more than $20,000,000 annually, and include electric light and power companies, gas companies and traction companies.

Mr. Insull has been a member of and active in the work of the N. E. L. A., and for several years has been a vice-president of the association. He was active in the reorganization program of the association and the broadening of the scope of service to be given by the association to member-companies.

A. I. E. E. to Hold Annual Convention

The thirty-sixth annual convention of the American Institute of Electrical Engineers will be held at the Greenbrier Hotel, White Sulphur Springs, W. Va., June 29 to July 2.

A comprehensive collection of papers will be presented at the seven technical sessions, covering subjects of particular interest in many phases of present-day practice.

Ample opportunity has been provided for recreation and entertainment. The committee has arranged so that the afternoons will be left open for the many entertainment features, including dancing, teas, card parties, golf and tennis tournaments, baseball and other special events.

The convention will be opened Tuesday morning, June 29, with the annual presidential address by President Calvert Townley, followed by the introduction of the president-elect. The remainder of the session will be devoted to the presentation and discussion of the annual reports of the technical committees.

The tentative program follows: Wednesday, June 30, Electrical Machinery Session and also a miscellaneous session; Thursday, July 1, Protective Devices, Electric Welding and Power Factor Sessions; Friday, July 2, Excitation Session.

Unless something is done immediately to relieve the car situation in the soft-coal regions of the country, the American public will find itself without coal for next winter, according to representatives of the United Mine Workers of America, who have come to Washington to seek a remedy. John Moore, president of the Ohio miners, sounded this warning. Mr. Moore pointed out that railroads are assigning a full supply of coal cars to those mines with which the railroads have contracts for coal and refusing to supply cars to the thousands of other mines so that the needs of the public might be filled. "Railroads consume approximately one-third of the total soft-coal output," he said, "and the public consumes the other two-thirds. But at present the railroads, especially in Ohio, are taking practically all of the coal that is being produced and leaving none for the public. Tens of thousands of coal miners are out of employment because the railroads refuse to supply cars to the mines on an equitable distributive basis."

Mr. Moore suggested as one method of relief that inasmuch as one-third of the coal produced is used by the railroads and two-thirds by the public, there should be an equitable distribution of coal among all mines and that the first carload be sent to the railroads and the next two carloads to the public.

The electric furnace in actual use has reached the temperature of 3,500 deg. C. Recent experiments, have, however, developed a furnace which gives a temperature of 4,500 C., enough to volatilize diamonds. A comparison of these temperatures with that of the sun, which is estimated at 5,000 C., gives a striking idea of what can be accomplished in handling refractory substances with electric heat.—*Sibley Journal.*

Spring Meeting A. S. M. E. at St. Louis

IN THE engineering history of St. Louis the week of May 24 was notable in that the city was the place of meeting of three of the large national engineering societies. The American Society of Mechanical Engineers, the American Society of Refrigerating Engineers and the American Society of Heating and Ventilating Engineers each came to St. Louis to hold the spring convention. Conforming with the co-operative tendency of the times, there were joint sessions, the entertainment and trips of inspection to industrial plants were in common, and the headquarters of all were at the Statler Hotel. The engineers of St. Louis are to be congratulated upon the success attending their efforts. Plans were made and executed upon a magnificent scale for the needs, the entertinment and the comfort of their guests. It was a profitable week, full of activity and full to the brim of Southern hospitality of the distinctive St. Louis brand.

First Session Monday Afternoon

Coming from Keokuk, where they had spent Sunday in reviewing the great low-head hydraulic plant of the Mississippi River Power Co., the mechanical engineers arrived in St. Louis Monday morning to hold a four-day meeting May 24-27. The total attendance was in the vicinity of 800. An afternoon session was held upon the day of arrival. Business was disposed of as quickly as possible. The tellers of amendments to the constitution reported the votes upon the specific changes recently submitted to members, practically unanimous in favor of each issue. The revised report of the Boiler Code Committee on Boilers for Locomotives was presented, and there was offered a tentative code of ethics intended for all engineers in common. It was recommended that the code be referred to the Engineering Council or such other body as may be formed, but that the efforts of the society committee be continued. An amendment was offered by President Miller to simplify amendment of the constitution, and there was considerable discussion, initiated by the Philadelphia section on admitting juniors to the privileges of voting and holding office, the object being to interest and hold the young engineer. A motion to authorize the council to contribute from the society's funds $5,000 to advance the cause of the Department of Public Works Association was lost, as this was conceived to be a case for individual subscription.

Appraisal and Valuation Session

Following was a session on appraisal and valuation, which was continued on Tuesday afternoon. The five papers listed and considerable written discussion were presented: "Rational Valuation—A Comparative Study," by J. R. Bibbins; "Price Levels in Relation to Value," by Cecil F. Elmes; "Data on the Cost of Organizing and Financing a Public-Utility Project," by the late F. B. H. Paine (contributed by Dean M. E. Cooley); "The Construction Period," by H. C. Anderson; "Appraisal and Valuation Methods," by David H. Ray. The first four papers had been introduced at the December meeting, but it was felt that the importance of the subject in these days of post-war readjustments, and the low value of the dollar, warranted continued consideration. The paper first named was a comparative study of valuation practice illustrated by a complete economic analysis of a large utility since the Civil War, yielding in substance the true history of the five-cent fare. The second paper traced the history of price levels and the purchasing power of money for several centuries back. The third and fourth papers analyzed various factors involved in the generally misunderstood term "overhead," relating in particular to the construction period, and the fifth discussed official methods of varying exactness.

The discussion of the papers pointed to the four winds. As there was no consensus of opinion as to "what constitutes a complete rational evaluation," a resolution was passed requesting the president to appoint a committee to digest all material on this subject presented in the past, with additional papers on fundamentals if necessary, so that the entire subject might be placed before the society again for discussion.

Local Session Tuesday Morning

On Tuesday morning there was a local session to which St. Louis engineers contributed. There were papers on "The Housing Problem in St. Louis," by Nelson Cunliff; "Industrial Housing—A Financial Problem," by Leslie H. Allen; and two papers on river transportation, by W. S. Mitchell and E. W. Schadek. The discussion centered on rail *vs.* water transportation. It was recognized that each had a place, notwithstanding the fact that water transportation had nearly disappeared from American rivers. Discrimination in railway rates, prejudices and politics had been responsible for the present situation. There was need for an unbiased body such as a Department of National Public Works, to consider the transportation problem from an economic or engineering standpoint. The progress made toward securing such a department was reviewed. Upon a resolution offered by M. Y. Tait the society went on record as fully endorsing the efforts of the National Public Works Association and urged the local sections to aid and support the work.

"Tight Fitting Threads for Bolts and Nuts" was the title of a paper by Chester B. Lord. Although generally the thread forms now in use are quite satisfactory, there is still demand for "a thread that will not loosen." The author pointed out the defects in present practice and the requirements of a male and female thread of the same lead and pitch diameter that may be made after repeated loosenings to fit right without the aid of a locking device.

To combustion engineers a paper on "Burning Eastern Coals Successfully on a Conveyor-Feed Type of Stoker," by Lloyd R. Stowe, was of interest as it emphasized the chemical side of combustion and introduced a new thought to those who had always considered the question from the mechanical standpoint. The stoker is of the traveling type made up of narrow chain-grate elements alternating with stationary tuyeres through which forced draft is applied. The stoker has an incline greater than is customary with the chain grate. The usual type of arch is employed, and there is a great expanse of bridge wall to direct the heat on the incoming fuel. Ignition temperatures are extremely high, and large quantities of air are forced through the fuel bed at the front, the slots in the tuyere being wider here, although subject to the same air pressure. It is claimed that the high temperatures decompose the tarry or resinous excretion from the coal and the major portion of the volatile-forming matter before the former can set up an appreciable primary structure and before the carbon of the latter can have time to impregnate any slight primary structure that may have formed. The absence of coke formation changes the character of the fire under the arch and has a marked influence on the last half of the fire. As coke is not formed in the distillation zone, the cemented coke lumps cannot be present in the final stages of combustion. The individual pieces of coal retain their identity as in the case of free-burning Illinois coal. This non-coking performance of Eastern coals was demonstrated in an experimental plant which was open for inspection during the convention. More will be said of this stoker in an early issue.

During the same period, at another session, the first issue of the "Code of Safety Standards for Elevators" was presented. It covered the construction, operation and maintenance of elevators, dumbwaiters and escalators. During the afternoon there was a public hearing by the Boiler Code Committee on "Rules for the Construction of Unfired Pressure Vessels." Much discussion on welded joints developed. It was the sense of the meeting that the welding portion of the report be revised. Tests and data were requested from manufacturers, and there were promises to send in such material. The revisions were to be made in time to submit at the December meeting.

On Wednesday morning there were simultaneous sessions on aëronautics and castings, the latter including papers on malleable, die, aluminum, steel, gray iron, brass and bronze castings.

Scientific Session

At a scientific session on Thursday the refrigerating and heating engineers participated. It was a joint session of the three societies, and from each the papers were contributed. Upon the request of the Power Test Code Committee of the society for advice on weir measurements and with funds from the Engineering Foundation, Clemens Herschel devised an improved form of weir for gaging in open channels, which was tested at the hydraulic laboratory of the Massachusetts Institute of Technology. The new design has no resemblance to the sharp-edged weir now in use. It has a 2:1 slope of approach to a circular crest which is hollow for observing the pressure at that point. The nappe of the stream is supported for a short distance beyond the crest by another 2:1 slope. In the first paper of the joint session Mr. Herschel gave a résumé of the history of weir measurements, described the new weir and incorporated the results of the tests. In the discussion there was call for more data and the privilege of installing weirs of the new type at the various universities to check up the data presented. It was felt that the sharp-crested weir would still be used for measuring comparatively small quantities of water such as power-plant returns or boiler feed.

A paper by Glenn B. Warren on "Simplification of Venturi-Meter Calculations," was read by title. The author described a method reducing the calculations involved in the venturi-meter measurement of the flow of compressed air, to simple slide-rule computations.

M. S. Van Dusen, of the Bureau of Standards, described the method that had been developed for measuring the thermal conductivity of commercial insulating materials. The equipment consisted of two copper plates, one on either side of an electric heating grid. At the edges there were auxiliary heating coils to keep the temperature of the guard ring equal to that of the inner square. Temperatures were measured by thermocouples. Probable errors in the use of this equipment were discussed, and slides were used to show the variation in thermal conductivity of pure corkboard with the density, conductivity of various kinds of wood across the grain, relative temperature drops through the various materials composing a wall, etc. Funds were not available at the present time to carry on this work, and rather than take the chance of losing valuable data and perhaps the men engaged in the work, a plea was made for funds, in particular from those interested in refrigeration and heating.

"The Dissipation of Heat by Various Surfaces," by T. S. Taylor, was a paper discussing the value of sheet asbestos as a covering for hot-air pipes. It was shown that 0.013-in. sheet asbestos over tin would dissipate about 37 per cent more heat than a bare tin pipe; with a layer of dust added 32 per cent more heat would be dissipated, and with a layer of dust only on the bare pipe the heat waste would be 7 per cent more than with the bare pipe. With 0.2-in. sheet asbestos the loss would be equal to that from bright uncovered pipe and with thicker applications of insulation there would be considerable saving. The effects of air velocity and the angle of incidence of the air upon the dissipation of heat were shown. In the discussion it was brought out that the comparative losses from dull and bright surfaces were in the ratio of 0.7 to 0.5 and that results different from those given in the paper would be obtained when gases, say from a boiler, passed through the flue.

"Ship Ventilation," by F. R. Still, was the final paper of the session. As there was no standard system, the author discussed the various methods employed.

Power and Combustion Session

At a simultaneous power and combustion session the following four papers were presented: "Pulverized Coal in Metallurgical Furnaces at High Altitudes," by Otis L. McIntyre; "Efficiency of Natural Gas Used in Domestic Service," by Robert F. Earhart; "The Separation of Dissolved Gases from Water," by J. R. McDermet; "Locomotive Feed-Water Heating," by T. C. McBride. The third paper listed discussed a process for removing the non-condensible gases from boiler-feed water. Briefly, there is rapid injection of heated water into a region of vacuo, and an explosive boiling of it at the expense of the heat of the liquid available to the vacuum, with a simultaneous recovery of the heat liberated to the vacuum by a heat exchanger or condenser cooled by the incoming water, preliminary to its heating. Elimination of corrosion from boilers and economizers, increased conductivities and higher vacua were the advantages claimed. The paper created prolonged and diversified discussion. Mr. McBride's paper described a system of locomotive feed-water heating in which exhaust steam in an open heater comes in direct contact with cold feed water. It was pointed out that there would be available a surplus of exhaust steam for the draft.

Entertainment Features

Entertainment began with the reception Monday evening. The engineers were made welcome by C. H. Howard, president of the Commonwealth Steel Co., and E. R. Jackson delivered an illustrated address on "The First Transcontinental Motor Convoy," which was followed by music and dancing. Numerous inspection trips to commercial plants of interest were arranged, and daily entertainment was provided for the ladies. The banquet was held Tuesday night at the Missouri Athletic Association. The feature was a most interesting address on "The German Defenses on the Coast of Belgium," by Lieutenant-Colonel H. W. Miller, of the Ordnance Department. Music and dancing were again the closing features. By Wednesday night the Heating and Refrigerating Engineers had arrived, and all spent a most enjoyable evening at a concert and dance divertissement given at the mammoth open-air municipal theater at Forest Park. On Thursday afternoon the joint entertainment feature was a boat ride up the Mississippi River with music, dancing and vaudeville selections.

Thursday night the Mechanical Engineers left for Tulsa to view the oil fields, and participate in a two-day meeting with the Mid-Continent Section of the society. It is probable that the next spring meeting of the society will be held in Chicago.

Maryland To Adopt A.S.M.E. Boiler Code

A bill of the American Uniform Boiler Law Society for Maryland, effective Jan. 1, 1921, for the creation of a Board of Boiler Rules prescribes rules and regulations for the construction and use of steam boilers in that state, which will conform with rules now in existence in other states. It provides for the free interchange of boilers between states, and by standardization increasing the efficiency of all boiler manufacturers and all makers of materials used with steam boilers.

The board, which will consist of the chairman of the State Board of Labor and Statistics, the Attorney General, and the chairman of the State Accident Commission, will be invested with full authority to formulate rules and regulations governing the proper construction and installation of boilers of over fifteen pounds to the inch, and they will be empowdered to formulate and enforce rules and also to provide for maintenance on a proper basis of safety.

The Boiler Code of the American Society of Mechanical Engineers will be used wherever possible; that is, it will be used provided it does not conflict with the existing Maryland rules.

Section V of the act makes provision for the enforcement of the rules and regulations of the board through a state system of boiler inspection or by any other method created by the board, or by the General Assembly of Maryland. The board, however, shall have no jurisdiction over the operation of boilers or fixing the qualifications of persons entitled to operate turbines.

The bill provides that in the future no boiler shall be installed or passed by any boiler inspector which does not measure up to the rules established by the "Board of Boiler Rules." Adequate fines and imprisonment are provided for violation of the rules.

St. Louis Meeting of Refrigerating Engineers

AS HAS been intimated in the report of the A. S. M. E. spring meeting, the American Society of Refrigerating Engineers was one of the three societies holding conventions at St. Louis during the week of May 24, the specific dates being May 26-28. Headquarters was at the Hotel Statler. The first session opened Wednesday morning with President Matthews in the chair. There was the usual business routine, consisting of committee reports, the announcement of 32 new members and other matters. The tentative code for the regulation of refrigerating machines and refrigerants was brought up and the proposed changes enumerated. The principal changes on pressures had not been decided. When complete, the tentative code was to go to the American Engineering Standards Committee, then to be issued as a national code. A question box was established to begin with the present meeting. Mr. Gould, secretary of the Institute of Meat Packers, a service bureau consisting of ten or eleven standing committees working every day, made a plea for assistance from the Refrigerating Engineers in establishing methods for computing unit costs of refrigeration to the different departments.

President Matthews departed from the usual formal address by giving a brief talk on the field of refrigerants from physical and chemical standpoints. He presented a chart listing the homogeneous series of univalent hydrocarbon radicals, including diagrams showing the molecular structure and indications of the boiling points of the different media. A second chart showed the temperature-pressure relations of the various refrigerants.

Joint Session, Wednesday Afternoon

On Wednesday afternoon there was a joint session with the American Society of Heating and Ventilating Engineers at which four papers were presented. "New Methods of Applying Refrigeration," by E. S. Baars, was the first. Not only new applications, but changes of methods in industries long using refrigeration, were reviewed. The paper will be presented later in abstract.

Director John R. Allen summarized a most interesting paper on "Theories of Heat Losses from Pipes Buried in the Ground." The laws governing these losses were discussed and applied in a general way to ordinary practice. Attention was called to the fact that the results given were not absolute and must be considered as relative. The following conclusions were drawn:

That the heat loss from a pipe is not proportional to the external surface of the pipe. The heat loss per square foot of pipe in small pipes is much larger than the heat loss per square foot in large pipes.

That the heat loss per linear foot of pipe becomes smaller relatively as the pipe diameter increases, so that a 16-in. pipe loses but little more heat per linear foot than a 12-in. pipe. In practice, therefore, it makes very little difference in the heat loss, whether a 12- or a 16-in. pipe is used, especially in dry ground.

That the heat loss from a pipe is not proportional to the thickness of the covering and that there is little advantage to be gained in a good covering in increasing the thickness of the insulation to more than 2 in.; in most cases, with a good covering, it would appear that 2 in. of covering is all that is necessary.

That the depth to which a covered pipe is buried in the soil makes little difference in the heat loss provided the center of the pipe is 2 ft. or more below the ground surface. Beyond 2 ft. in depth, unless the pipes are very large, the heat loss from the pipes remains substantially the same for all depths.

That the heat loss from a pipe is not proportional to the conductivity of the covering, as the conductivity of the ground is as important a factor in the heat losses as the conductivity of the covering.

That poor covering in dry ground will give better results than good covering in wet ground. It is not possible, therefore, to guarantee the heat loss from a covering in the ground, as such a guarantee involves guaranteeing the conductivity of the ground.

Exceptions were taken to most of these conclusions by L. B. McMillan, consulting engineer for the H. W. Johns-Manville Co., and George B. Nichols.

In a paper on "Heat Insulation Facts" L. B. McMillan gave a comprehensive discussion on what insulation is, what it does and how it does it. The final paper of the session, on "Automatic Control of Temperatures," by R. P. Brown, president of the Brown Instrument Co., was read by title. The paper dealt with thermometer and pyrometer electrical control employed by the company.

The joint session on Thursday with the mechanical and heating engineers has been covered in the A. S. M. E. report.

Friday Morning's Session

At the Friday morning session there were two papers dealing with the small household refrigerating machine. The first, by G. A. Kramer, outlined the construction of the "Frididore" outfit, which employs a charge of from 2 to 5 lb. of methyl chloride mixed directly with the lubricant. Stuffing boxes, diaphragm and float-operated valves, and the location of the thermostatic control element were discussed in general. Data given during the discussion of the paper placed the cost for current per 100 lb. of refrigeration at close to 40c. A power requirement of 2.5 kw.-hr. per 100 lb. of refrigerating effect was another relation advanced.

In the second paper R. F. Massa stated that it was impossible to give the standard rating used for large machines to the small domestic outfit built into the refrigerator, owing to the variations in construction, type of cooling and refrigerant. Rating by piston displacement or size of ice compartment was also troublesome. The truth was that in most cases the builders wanted no comparative results. The small machine should be rated on the service rendered and under what conditions it will do the work, the capacity being expressed on an hourly basis.

W. G. E. Rolaff described his rotary compressor for refrigeration work. The machine is somewhat similar to a sliding blade pump, with the exception that the cylinder rotates to reduce the relative movement to the difference between peripheral velocities and thus reduce the scraping wear on the blade. The compressor operates at high speeds and is built for pressures of 75 lb. and up. The construction was illustrated and rather extravagant claims made as to its performance. A unique feature is the spraying of the lubricating oil into the suction. The oil seals the machine, preventing leakage, and as it is previously cooled, helps to improve the volumetric efficiency.

A report was read in which it was proposed to use 144 B.t.u. as the latent heat of ice in practical commercial work. It resulted in round figures for the usual units and was so near the 143.5 established by the Bureau of Standards that the error introduced would be negligible.

Afternoon Session, Friday

At the final session, Friday afternoon, Nelson J. Waite, presented a paper on "Direct Expansion Piping in Egg Rooms." This type of cooling had been distrusted in the old days, owing to the difficulty of holding the room in a dry state and the consequent musty odor imparted. Improved construction and the adoption of a lower carrying temperature now made direct expansion quite feasible. In a single small room the use of a single ceiling coil was recommended and in a larger room, several sections of ceiling coils all in the same horizontal plane.

In the discussion of the paper more surface and higher temperatures in the coils was recommended for bunker service with forced circulation. Exception was taken to the single-coil arrangement. Heat leakage would make the temperature higher at the walls and probably cause trouble from the resulting variation in humidity. As a factor of safety brine had something in its favor, but was less efficient and less flexible when storing different products.

George M. Kleucker described a water-distributing device for atmospheric condensers, designed to overcome the troubles experienced with slotted water pipes, serrated troughs or overflow gutters. The new trough had a vertical wall on one side, a sloping wall on the other side and a flat bottom with removable plugs through which accumula-

tions of dirt could be flushed out. A baffle was attached to the sloping side and through holes in the trough wall, water spouted against this baffle; then all of the water ran down evenly over the top pipe of the stand. Division strips between the pipes helped to hold the water together and guide it downward. The maximum flow to the condenser was 2½ gal. per minute to the foot of length. As these baffle or deflector plates were made as long as ten feet, it was thought in the discussion that so long a strip of metal would tend to wind. Serrating the bottom edge would probably improve the distribution of the water.

"Pulverized Coal for Boiler Firing," by H. G. Barnhurst, was the final paper.

In closing, Mr. Tait, who was acting as temporary chairman, said that he had been impressed favorably with the combination meeting, that it was his desire to see them continue with the programs arranged, if possible, to allow more interchange between the societies.

As previously mentioned, the entertainment was in common with the other two societies and has been covered, with the exception of the combination banquet held at the hotel by the refrigerating and heating engineers. George Wells, of St. Louis, was toastmaster, and the speaker of the evening, Carl J. Baer, on the engineer's position in reconstruction. It was his thought that engineers did not study other fields as they should and as a consequence were not prepared to assume their full duties. In a very interesting way the speaker traced the inter-relations of commerce, production of raw materials, industry and transportation, showing the need of co-operation, one with the other. There were short talks by the two presidents, Dr. Hill and Mr. Matthews. The evening closed with music and dancing.

Heating and Ventilating Engineers Meet at St. Louis

FROM May 26 to 28 the American Society of Heating and Ventilating Engineers held its spring convention in St. Louis in conjunction with the Mechanical and Refrigerating Engineers. In the reports of these societies mention has been made of the joint sessions, the joint entertainment and the combination banquet with the refrigerating engineers. Hotel headquarters was at the Statler, but the meetings of the society were held in the Board of Education Building. At the opening session Wednesday morning, W. E. Rolfe, president of the Associated Engineering Societies of St. Louis, gave the address of welcome. Response was made by Dr. Hill, president of the society.

Committee Reports

To save time reports of chapters were eliminated, as tney would appear in the *Journal*. Committee reports was the next order of business. The report of the Committee of New York Chapter on Industrial Engineering was important. It covered briefly causes of industrial unrest, remedies needed, responsibility of the engineering profession and a declaration of principles, closing with the recommendations for the society's actions, which were adopted at the meeting. In these recommendations the society approved and adopted the "declaration of principles" established by the American Society of Mechanical Engineers. Also the society is to appoint a standing committee of five, with the privilege of appointing subcommittees, to study economic and industrial problems, to arouse the interest of the society membership in the responsibility and opportunity of the engineer to assist in the present situation and to co-operate with committees of other engineering societies in developing united constructive action, in carrying out a comprehensive educational campaign for a term of years and finally in supporting and helping to co-ordinate and make effective all good constructive agencies, such as the Second Industrial Conference at Washington, the interchurch movement, etc.

James A. Donnelly, chairman of the Committee to Investigate Capacities of Steam and Return Mains, presented the report. At the annual meeting the committee was authorized to collect data on standard sizes of low-pressure steam and return mains. Tables of pipe sizes and a list of questions were submitted for the purpose of collecting this information, the various chapters being requested to co-operate. For the first time a standard table in full detail was prepared for each type of system. The tables distinguished between wet and dry drip mains and returns, and another new feature was a request for data on critical velocities. This is the velocity at which there is sufficient separation of steam and condensation, so that defective circulation or water hammer will not occur. This does not necessarily mean complete separation. The entire matter, with the data that is expected, will be submitted at the annual meeting. Other committee reports scheduled were deferred.

On Wednesday afternoon there was the joint meeting with the Refrigerating Engineers, and on Thursday the meeting of the three societies. Both of these sessions have been covered in the other reports.

On Friday morning there was a school-ventilation session with six papers. "The significance of Odorless Concentration of Ozone," by E. S. Hallett, gave assurance to those who might be desirous of using ozone in ventilation. The author stated that ozone in ventilation must be put on the same rigid practical basis as the heating system. It must have a standard of concentration based upon a mechanical unit and capable of convenient manual or automatic control, using chemical processes as a check only. With such equipment kept clean, as it must be to be effective, no apprehension need be felt as to results. In discussing the contribution, it was suggested that the society's Research Bureau make tests of the use of ozone to see if the results given by Mr. Hallett could be generally duplicated.

Two papers on the ventilation of large auditoriums were presented, one by S. R. Lewis, dealing specifically with observations made on an auditorium having air inlets in the window sills, and the other by R. S. M. Wilde, on the practical ventilation of modern theatres. In the discussion of the papers Mr. Hart differentiated between floor and overhead admission. With the former he did not favor automatic control due to the likelihood of sudden fluctuations objectional to occupants. With the supply overhead these fluctuations were pleasant rather than otherwise.

Training the School Janitor

E. S. Hallett told how the janitors and custodians of St. Louis schools were trained. In these schools about 200 boilers, an equal number of engines and blast fans, air washers, heat-regulation systems, vacuum cleaning systems, electric lights and plumbing were operated by untrained janitors. Under these conditions two supervising engineers were kept on the jump even to keep the plants running. To relieve the pressure of supervision and to get results from the heating apparatus, a system of training was inaugurated and elemental instruction given in combustion, methods of firing, regulation of heat, humidity and all essentials. The paper contained a complete outline of the course. The results were most gratifying. The discussion was complimentary, particularly by those who had visited the schools, and the establishment of night schools throughout the country for janitors was urged. Mr. Hallett explained that the reason for the satisfactory conditions obtaining in St. Louis was that the public-school system was under state control. The appointment of janitors had been taken out of the field of local politics, the janitors being civil-service men.

"High Efficiency Air Flow," by F. W. Caldwell and E. N. Fales, was an interesting paper dealing with the development of a means for visualizing air flow, with model studies made in the wind tunnel at McCook Aviation Field, Dayton. The final paper of the session on "The Sizing of Ducts and Flues for Ventilating and Similar Apparatus," by H.

Eisert, was a technical contribution bringing in theoretical considerations and exact methods which for the most part must be overlooked in commercial practice owing to the difficulties involved and the irregularities of construction. It was pointed out in the discussion that the author might have made an important point of the obstructions to flow such as were offered by bolt heads, as these probably would outweigh in importance many of the factors considered; for example, frictional resistance.

Symposium on Health and Humidity

Friday afternoon was devoted to a symposium on health and humidity, with two papers bearing on the use of wet-bulb temperature readings as the best method of indicating proper air conditions. E. V. Hill and J. J. Aeberly discussed "The Relation of the Death Rate to the Wet-Bulb Temperature," and O. W. Armspach presented a paper on "The Relation of the Wet-Bulb Temperature to Health." In the course of the discussion J. R. McColl said that he had found in an investigation of 32 school buildings in Detroit that for every pound of steam used for heating, three pounds was used for ventilation. In other words, the ventilating load was three times the heating requirements.

Adoption of a standard as a measure of ventilation was the next consideration. Director John R. Allen offered a resolution naming the Synthetic air chart, devised by Dr. E. V. Hill, as meeting the requirements of such a standard. Dr. Hill explained how the chart had been developed for the Chicago Commission of Ventilation, the present form being the eighth revision since it was first brought out in 1912. The resolution was adopted unanimously and it was further moved to appoint a committee of five to prepare an interpretation of the chart and explanations of the methods of determining the quantities considered. It was voted to appoint another committee of five to develop standard methods of testing heating systems.

In a paper on "Commercial Dehydration" J. E. Whitley showed some of the commercial possibilities of removing moisture from foodstuffs and established the economic advantages, giving a clear indication of the wide scope of the field. W. S. Scott spoke on the subject of "Industrial Electric Heating," a field increasing in prominence, not because electric heat is cheaper than other forms of heating, but because results unattainable heretofore have been effected, reducing the cost of the completed product, lessening the labor required, increasing the output and producing a product of uniform quality. Various applications were discussed, the equipment described and a summary made of the advantages.

Before adjourning a suggestion was received from John F. Hale that the annual meeting be held in Philadelphia with a business session in New York to comply with the constitution. As an alternate Mr. Hart suggested that the annual meeting be held in Pittsburgh at the Research Bureau and that the next semi-annual meeting be held at the same time and same place as that of the National Association of Heating and Piping Contractors, the probable selection being Atlantic City. This combination meeting was desirable and it would divide the meetings between the East and the West. A vote showed Mr. Hart's suggestion to be the sense of the meeting.

Large Transformers

The largest single-phase power transformers developed so far, according to the N. E. L. A. Electrical Apparatus Committee's report, are in a 70,800-kva. bank of transformers made up of three 23,600-kva. single-phase units, to step up from a delta generating voltage of 11,500 volts 60 cycles, to a star line voltage of 66,000 or 132,000 volts. These units are of the shell type, having a temperature rise of 55 deg. C. at full load, and the guaranteed efficiency at full load is 99 per cent. The height to the tips of the high-voltage bushings is 22 ft. and the largest floor-space dimensions of each unit lie within a circle whose diameter is 10 feet, 3 inches. An installation of two 12,000-kva. 4,500- to 27,600-volt three-phase self-cooled outdoor transformers, are the largest capacity of this type thus far built.

Personals

H. N. Aikman, recently with Dwight P. Robinson & Co., New York City, is now associated with the Fargo Engineering Co., Jackson, Mich.

G. C. Ward has been appointed a vice president and will be in charge of operation and construction for the Southern California Edison Company.

Fred E. Sermulin has resigned as test engineer of the Bethlehem Steel Co. and has accepted a position with R. H. Warren, consulting engineer of Easton, Pa.

Harold B. Vincent, formerly management engineer of the Day & Zimmerman Co., Philadelphia, has been promoted to commercial engineer of the same company.

Lafayette Hanchett has been elected president of the Utah Power and Light Co., Salt Lake City. He succeeds D. C. Jackling, who resigned a short time ago.

Walter E. Daggett, formerly engineer of the Osborn Manufacturing Co., Inc., of Cleveland, Ohio has opened sales-engineering offices in the northern part of the state.

A. Y. Dodge, formerly assistant plant and tool engineer with the Wallis Tractor Co. of Racine, Wis., has accepted the position of chief engineer with the Racine Engineering Co.

Dr. Lamar Lyndon, consulting engineer, 13 Park Row, New York City, who has been out of the country for several months, has returned and announces that he has resumed practice.

John A. Lawrence, formerly assistant mechanical engineer of the New York Edison Co., New York City, has assumed the position of engineering manager for Thomas E. Murray Inc., New York City.

H. G. Harvey has accepted a position in the commercial department of the Pennsylvania Utilities Co., Easton, Pa. He was formerly commercial engineer of the Nassau Light and Power Co., Mineola, L. I.

Walter J. Bitterlick, formerly plant engineer for the Hood Rubber Co. of Watertown, Mass., has taken the position of engineering superintendent of the new plant of the Seamless Rubber Co., New Haven, Conn.

William K. Sanderson, chairman of the St. Thomas (Ont.) Hydro-Electric Utilities Commission, was elected president of the Ontario Municipal Electric Association at the recent annual convention of the association.

Harry I. Beardsley has resigned as supervising mechanical designer with the Crocker-Wheeler Co., Ampere, N. J., and is associated with the Western Electric Co., New York City, in the capacity of specification engineer.

Sterling H. Bunnell has resigned his position as chief engineer with R. Martens & Co., Inc., of New York City, and has become associated with the Engineering and Appraisal Company, Inc., with offices in New York City.

I. Beller, until recently connected with Balbach Smelting and Refining Co., of Newark, N. J., in the capacity of designing engineer, has become affiliated with the Chile Exploration Co. (Braden Copper Co.), of New York City.

Harry Deverell has severed his connection with Deverell, Spencer & Co., Baltimore, Md., and has opened offices in Baltimore as a sales engineer for machinery, especially elevating, conveying and power-transmission machinery.

William D. Ennis, vice president and secretary, announces the organization of the Technical Advisory Corporation, with offices in the Vanderbilt Building, New York City. The corporation will act as consulting engineers, industrial economists and advisors.

N. Baad, who formerly had charge of the heat-treating department at the De La Vergne Machine Co., of New York, has resigned to take a position as sales and service engineer with the F. A. Calhoun Co., 76 Montgomery St., Jersey City, N. J.

Douglas Sprague and Chester A. Slocum, associate consulting engineers, announce that they are now located at 167 West Thirteenth St., New York City. The firm renders service in ventilation, sanitation, heating, electricity, power plants, reports and valuations.

Society Affairs

Atlanta Section, A.S.M.E., will meet June 29. Election of officers will take place.

The Universal Craftsman Council of Engineers will hold its annual convention at Springfield, Mass., Aug. 3-6.

Chicago Section, A.S.M.E., will meet on June 21 at the Western Society of Engineers Club. Subject: "Refrigeration."

The National Association of Safety Engineers, Ohio Section, will hold its annual convention June 17, 18 and 19 at Columbus, Ohio.

The Association of Iron and Steel Electrical Engineers will hold its fourteenth annual convention in September at New York City.

The New York State Association, N. A. S. E., will hold its twenty-fifth annual convention at the Temperance House, Niagara Falls, N. Y., on June 10, 11 and 12.

The National Association of Safety Engineers, Connecticut Section, will hold its annual convention at Bristol on June 26 instead of at Norwich, as previously announced.

The Buffalo Section of the A. S. M. E., at a meeting held at the University Club, elected the following officers for the season of 1920-21: B. S. Hughes, chairman; W. J. Gamble, vice chairman; W. J. Boyd, secretary; W. M. Dollar, treasurer; and C. A. Booth.

The Chamber of Commerce, U. S. A., at its annual meeting in Atlantic City in April elected as directors of the Chamber two engineers: Howard Elliott, a member of the American Society of Civil Engineers and chairman of the Board of the Northern Pacific R.R. and L. B. Stillwell, past President, American Institute of Consulting Engineers and of the American Society of Civil Engineers.

Membership of the National Engineering Societies has increased rapidly. The latest membership figures are as follows: American Society of Civil Engineers, 9,515 (May 14, 1920), American Institute of Mining Engineers, 8,532 (May 10, 1920), American Society of Mechanical Engineers, 12,258 (May 14, 1920), American Institute of Electrical Engineers, 11,345 (May 1, 1920), Society of Automotive Engineers, 4,798 (May 8, 1920).

New Professional Sections of A.S.M.E.—Aëronautics, Cement, Fuels, Gas Power, Industrial Engineering, Machine Shop Practice, Ordnance, Power, Railroads, Textiles have already been authorized—furnish a unique opportunity for engineers specializing in these various fields to take part in a movement for the development of their specialties through meetings, papers and debate, backed up by a national organization of over 12,000 members.

Engineers of Eastern New York to Affiliate—A meeting of representatives of the various engineering organizations in the cities of Albany, Schenectady, Troy and surrounding towns was held at Albany on May 13. The following organizations were represented: The Albany Society of Civil Engineers (a local independent organization), the Albany Chapter of the American Association of Engineers, the Eastern New York Section of the A.S.M.E., and the Schenectady Section of the A.I.E.E. Resolutions were passed requesting each organization to appoint an official representative to serve on a committee to draft a constitution providing for the affiliation of the various local sections of national societies with the Society of Engineers of Eastern New York, thereby making the latter the dominant force in that territory. It is hoped to put the plan into operation next October when the engineering meetings again become active.

Miscellaneous News

An International Exhibition of the products of the mine, the soil and the sea, and of arts, industries and manufactures, to take place in Philadelphia in 1926, to celebrate the 150th anniversary of the signing of the Declaration of Independence is proposed in a bill which has been introduced by Representative Darrow, of Pennsylvania.

The Bureau of Mines, in a recent statement on the development of lignite, says: The efforts to make the lignite of Texas, North Dakota and other Western States so serviceable to that part of the country that it will be unnecessary in the future to ship in other coal at great expense are to be inaugurated immediately by the Bureau, at New Salem, N. D., in co-operation with a company there.

The Sixth National Exposition of Chemical Industries will be held at the Grand Central Palace, New York, during the week ending Sept. 25. This year the exposition will have three special sections—the Electric-Furnace Section, the Fuel-Economy Section and a Materials-Handling Section. The Fuel-Economy Section will consist of exhibits of machinery and apparatus, furnaces, producers, stokers and all devices for the economic utilization or more efficient combustion of coal. The Materials-Handling Section will include exhibits of conveying, transporting and elevating machinery. Included in this will be weighing, measuring and power-transmission equipment.

Business Items

The Hammel Oil Burning Equipment Co., Inc., is now located at 1476 Broadway, New York City.

James Walker & Co., Ltd., announce the removal of their offices and storeroom to 46 West St., New York City.

Westinghouse Church Kerr & Co., Inc., announce the removal of their offices from 37 Wall St. to 125 East 46th St. Until completion of the merger with the Dwight P. Robinson & Co., Inc., the business will be conducted under the same name.

The General Electric Co. has completed negotiations for the purchase of the former munitions plant of the Bartlett-Hayward Co., at Baltimore, Md. The plant consists of eleven buildings having 420,000 sq.ft. of floor space and occupying a forty-acre site.

The Worthington Pump and Machinery Corporation, 115 Broadway, New York, announces that it has completed preparations to furnish improved water-power machinery of all capacities for low-, medium- and high-head service, including oil-pressure systems, waterwheel governors and other auxiliaries.

The Roller-Smith Co., New York City, announces that it has made an agency arrangement with the W. Montelius Price Co., Seattle, Wash., to handle the Roller-Smith Company's line of electrical instruments, meters and circuit breakers in the States of Washington and Idaho, and part of the State of Oregon.

The Cross & Simmons Company, Inc., Chicago, has changed the name of the organization to The Simmons Associates, Inc. No change in the personnel of the company is involved except that John H. Cross, formerly president, becomes vice president, and H. H. Simmons, formerly secretary and treasurer, becomes president.

The Pennsylvania Pump and Compressor Co., Easton, Pa., announces the opening of its sales offices in the following cities: New York, 50 Church St., H. C. Browne, manager; Philadelphia, 2222 Chestnut St., W. J. Devlin, manager; Pittsburgh, 631 Fulton Building, C. W. Gellinger, manager; Richmond, Va., Mutual Building, W. F. Delaney, manager; Birmingham, Ala., 2027 Jefferson Bank Building, H. F. Kahn, manager; Salt Lake City, Utah, Newhouse Building, C. H. Jones, manager; Milwaukee, Wis., 604 First National Bank Building, Coates & Zarling, representatives.

Trade Catalogs

The Industrial Arts Index, March issue, is now ready for distribution. Periodicals and technical magazines are indexed in this book in such a manner that any publication can be easily found. The name of the magazine, volume number, including paging and date is given. Note is made also of illustrations, maps and charts.

The National Educational Committee of the N. A. S. E. has published a 35-page booklet entitled, "The Use and Value of Exhaust Steam." A chapter is also devoted to practical pipe covering. A number of interesting tables showing heat losses from uninsulated hot surfaces, as well as curves showing heat loss per degree temperature difference per square foot per hour—B.t.u. are given. A copy of the booklet can be secured for fifteen cents.

The Dwight Manufacturing Co., 565 West Washington Boulevard, Chicago, is issuing for distribution upon request a 20-page booklet devoted to the Dwight CO_2 indicator of the spring-gage and mercury-gage types, the motion recorder developed by the company, feed-water and flue-gas thermometers, and Ellison differential draft gages. The booklet is instructive and should prove of interest to engineers or anyone having use for the products named.

The Bridgeport Brass Co., Bridgeport, Conn., has ready for distribution a new 78-page booklet entitled "Seven Centuries of Brass Making." A brief history of the ancient art of brass making and its early method of production is contrasted with modern electric methods. The important steps in the making of tubes, sheets, rods and wire are shown. The properties of brass as affected by composition, cold-working and heat treatment are given with the idea of assisting engineers in drawing specifications.

The Iron Age Publishing Co. New York has ready for distribution a new 1,216-page illustrated catalog entitled "The Iron Age Catalog of American Exports." It contains the catalogs of leading American manufacturers of engineering, railway, foundry and electric equipment and supplies; iron and steel machinery and tools, hardware and cutlery. The catalog contains over three thousand illustrations and specifications, data and other information which will make it useful to the technical as well as other buyers.

The Fairbanks Co., Broome and Lafayette Sts., New York City, has just completed publication of a new 256-page catalog on power transmissions appliances and elevating and conveying machinery. Complete descriptions, accompanied by illustrations of the apparatus handled by the company, are contained in the booklet. In addition, full data as to dimensions, capacities, etc., are given, making it a useful handbook for the man who designs or installs mechanical equipment of this nature. A copy will be sent on request.

Briggs & Turivas, Inc., dealers in scrap iron and allied metals, iron and steel products, obsolete and salvageable material and equipment, Chicago, New York and Toronto, Canada, in a 48-page pocket size booklet, have presented valuable information for the producer and user of these materials. In this publication the various grades of iron and steel scrap as marketed are described and classified. The data being compiled from average practice, will fit closely almost every probable contingency. A table shows weights and quantities of rails and accessories in various combinations of tonnage and length of track. Other tables show net and gross ton equivalents, a tonnage card, weights of plate, standard gages and specific gravities and weights.

COAL PRICES

Prices of steam coals both anthracite and bituminous, f.o.b. mines, unless otherwise stated, are as follows:

ALANTIC SEABOARD

Anthracite—Coals supplying New York, Philadelphia and Boston:

	Mine
Pea	$5.30@$5.75
Buckwheat	3.40@ 4.10
Rice	2.75@ 3.25
Barley	2.25@ 2.50
Boiler	2.50

Bituminous—Steam sizes supplying New York, Philadelphia and Boston:

Latrobe	$4.25@ $4 50
Connellsville coal	6.00@ 7.00
Cambrias and Somersets	4.35@ 5 15
Clearfields	6.25@ 7 50
Pocahontas	7.00@ 8.00
New River	7.00@ 8.00

BUFFALO

Bituminous

Pittsburgh slack	$6.00@ $8.00
Mine-run	6.00@ 8.00
Lump	6.00@ 8.00
Youghiogheny	6.00@ 8.00

CLEVELAND

Bituminous—Prices f.o.b. mines:

No. 6 slack	$4.50@ $6.00
No. 8 slack	4.50@ 6.00
No. 8—¾-in.	4.50@ 6.00
No. 6 mine-run	4.50@ 6.00
No. 8 mine-run	4.50@ 6.00
Pocahontas—Mine-run	4.50@ 6.00

ST. LOUIS

Anthracite

	Williamson and Franklin Counties	Mt. Olive and Staunton	Standard
Mine-run	$3.00@ 4.00	$4.00@ 5.00	$3.75@ 4.25
Screenings	3.00@ 4.00	4.00@ 5.00	2.75@ 3.50
Lump	3.00@ 4.00	4.00@ 5.00	4.00@ 4.50

Williamson-Franklin rate to St. Louis is $1.10; Other rates 95c.

CHICAGO

Bituminous—Prices f.o.b. mines as per circular of April 1 are as follows: Co. prices vary from 50c. to $1.25

		Freight rate Chicago
Illinois		
Southern Illinois		
Franklin, Saline and Williamson Counties		
Mine-Run	$3.00@ $3.10	$1.55
Screenings	2.60@ 2.75	1.55
Central Illinois		
Springfield District		
Mine-Run	$2.75@ $3.00	$1.32
Screenings	2.50@ 2.60	1.32
Northern Illinois		
Mine-Run	$3.50@ $3.75	$1.24
Screenings	3.00@ 3.25	1.24
Indiana		
Clinton and Linton		
Fourth Vein		
Mine-Run	$2.75@ $2.90	$1.27
Screenings	2.50@ 2.65	1.27
Knox County Field		
Fifth Vein		
Mine-Run	$2.75@ $2.90	$1.37
Screenings	2.50@ 2.60	1.37
Brazil Bloke	$4.25@ $4.50	$1.27

New Construction

PROPOSED WORK

Me., Brunswick—The Cabot Mfg. Co. had plans prepared for the construction of a power plant in connection with its proposed cotton mill.

Mass., Boston—The School Bd. Comn. plans to build a 2 story school building in the George Putnam Dist. and a 2 story school building in the Lewis Dist. Steam heating systems will be installed in same. Total estimated cost, $600,000.

Mass., Boston—The School Bd. Comn. will receive bids about Sept., for the construction of a 2 story, 180 x 180 ft. school on Maxwell and Seldon Sts. and a 3 story, 150 x 300 ft. school on Avenue Louis Pasteur. Steam heating systems will be installed in same. Total estimated cost, $1,620,000

Mass., Mansfield—The Mansfield Housing Corp., c/o Bonelli, Adams & Co., 60 State St., Boston, will soon award the contract for the construction of fifty 1 and 2 story frame houses on various lots. A hot air heating system will be installed in same. Total estimated cost, $250,000.

Mass., Worcester—J. D. Leland, Archt., 185 Devonshire St., Boston, will soon award the contract for the construction of a 4 story, 200 x 210 ft. administration building, for the Reed & Prince Mfg. Co., Duncan Ave. A steam heating system will be installed in same. Total estimated cost, $500,000.

Conn., Hartford—Cortlandt F. Luce, Archt., 36 Pearl St., will soon award the contract for the construction of a 7 story, 147 x 150 ft. garage, etc., on Hicks and South Ann Sts., for the Hartford Automobile Club Garage Co., 36 Pearl St. A steam heating system will be installed in same. Total estimated cost, $500,000.

Conn., Waterbury—The Connecticut Light & Power Co., 111 West Main St., has awarded the contract for the construction of a 2 story, 25 x 90 ft. power plant addition, to Dwight Wooster, 39 Harvard St., Waterville. Estimated cost, $50,000.

N. Y., Cranesville (Amsterdam P. O.)—The Adirondack Electric Power Corp., Glens Falls, plans to construct an electric power plant near here.

N. Y., Jamestown—The Bd. of Hospital Comrs. will receive bids until June 8 for the addition to laundry building, boiler house, etc., at the hospital here. J. W. Rulifson, 168 East 3rd St., Archt.

N. Y., Lockport—The Lockport Light, Heat & Power Co. is issuing $350,000 worth of preferred stock. The money will be used for extensions and improvements.

N. Y., New York—The Amateur Comedy Club, 150 East 36th St., is having plans prepared for the construction of a 7 story, 50 x 100 ft. club house at 122-124 East 51st St. A steam heating system will be installed in same. Total estimated cost, $200,000. O. C. Herring, 8 West 33rd St., Archt. and Engr.

N. Y., New York—The Natl. Drug Works Corp., 405 Lexington Ave., plans to build a 22 story office building on 42nd St. near 5th Ave. A steam heating system will be installed in same. Total estimated cost, $2,000,000. C. H. Seymour, Archt. and Engr.

N. Y., New York—The New York Edison Co., Irving Pl. and East 15th St., plans to build a transformer station at Dunwoodie. A steam heating system will be installed in same. Total estimated cost, $150,000. W. Whitehill, 55 Duane St., New York City, Archt. and Engr.

N. Y., New York—The New York Edison Co., Irving Pl. and East 15th St., plans to build a transformer station at the bowery and another one on 73rd St. Steam heating systems will be installed in same. Total estimated cost, $300,000. W. Whitehill, 52 Duane St., Archt. and Engr.

N. Y., New York—S. W. Straus & Co., 150 B'way, is having plans prepared for the construction of a 9 story, 100 x 180 ft. bank, office and store building on 5th Ave. and 46th St. A steam heating system will be installed in same. Total estimated cost, $4,000,000. Warren & Wetmore, 10 East 47th St., Archts. and Engrs.

N. Y., Poughkeepsie—The Central Hudson Gas & Electric Co. has filed an application with the Pub. Serv. Comn., Albany, for permission to construct extensions to its transmission system to the towns of Ulster, Esopus and Millbrook. Estimated cost, $25,000.

N. Y., Rocky Point—The Radio Corp., Woolworth Bldg., New York City, is having plans prepared for the construction of a wireless station consisting of several buildings including a power house. Total estimated cost, $10,000,000. J. G. White Eng. Corp., 43 Exch. Pl., New York City, Engr.

N. Y., Whitehall—The Consolidated Light & Power Co. has filed an application with the Pub. Serv. Comn. for permission to construct and operate a local electric light and power plant as well as transmission system.

N. J., Lakehurst—The Bureau of Yards & Docks, Navy Dept., Wash., D. C., will soon award the contract for furnishing and installing 3 turbo-alternators, cooling ducts, 2 exciter sets, switchboard, electric power and lighting systems, 2 motors with controllers and belts for air compressors, compressors, Wickes boilers, superheaters, mechanical stokers and engines, 3 boiler feed pumps, feed water heater, sump pump, coal and ash handling equipment, 2 fire pumps in the power plant at the Naval Air Station, here.

N. J., Morris Plains—The state rejected all bids for the installation of a heating, plumbing and electrical work in the 2 proposed 3 story, 88 x 230 ft. treatment buildings. Work will be readvertised.

Pa., Allentown—The Phoenix Silk Mfg. Co., Race and Court Sts., is having plans prepared for the construction of a power plant at its silk mills here. Carl A. Baer & Co., Land Title Bldg., Philadelphia, Engrs.

Pa., Philadelphia—The Franklin Trust Bldg., 20 South 15th St., plans to build an 11 story, 20 x 90 ft. office addition. A steam heating system will be installed in same. Total estimated cost, $500,000. DeArmond, Ashmead & Bailey, Franklin Trust Bldg., Archts.

Pa., Reading—Wilmer & Vincent, 1151 B'way, New York City, is having plans prepared for the construction of a 150 x 160 ft. theatre, office and store building on 10th and Penn Sts. A steam heating system will be installed in same. Total estimated cost, $650,000.

Del., Wilmington—The B. P. O. E. plans to construct a club house. A steam heating system will be installed in same. Total estimated cost, $400,000. DeArmond, Ashmead & Bailey, Franklin Trust Bldg., Philadelphia, Pa., Archts.

Md., Baltimore—The Delion Tire Co., 131 West Mt. Royal Ave., is having plans prepared for the construction of a 1 story, 90 x 400 ft. tire factory and a 2 story, 60 x 70 ft. power plant and office on Mt. Royal Ave. Total estimated cost, $100,000. R. B. Arnold, 131 West Mt. Royal Ave., Engr. J. O. Hunt, 114 North Montgomery Ave., Trenton, N. J., Archt.

Md., Baltimore—McKenzie, Vorhees & Gmelin, Archts., 1123 B'way., New York City, will soon award the contract for the construction of a telephone exchange building on Kate Ave., for the Chesapeake & Potomac Telephone Co., 5 Light St. A steam heating system will be installed in same. Total estimated cost, $250,000.

Md., Massey—The Town Council plans to install an electric lighting plant here.

Md., Port Covington—(Baltimore P. O.)—The Consolidated Gas, Electric Light & Power Co., Lexington Bldg., will soon award the contract for the construction of a 1 story, 26 x 46 ft. substation along the water front. Estimated cost, $80,000.

W. Va., Cecil—The Sterling Coal Co. is having plans prepared for the reconstruction of the electric power plant and coal tipple at its properties recently destroyed by fire.

W. Va., Wheeling—The Wheeling Electric Co. had plans prepared for the construction of a power loop to run through Fulton at Rudler's where a substation will be erected, and continue on a straight line north to Windsor. The substation will supply the suburban districts.

O., Canton—The Bd. Educ. will receive bids until June 19 for the construction of a 3 story, 140 x 250 ft. high school on 14th St. A steam heating system will be installed in same. Total estimated cost, $1,000,000. Thayer & Johnston, 3716 Euclid Ave., Cleveland, Archts.

O., Cleveland—Jacob Babin and others, 13661 Euclid Ave., has leased a site and plans to build a 20 story, 50 x 151 ft. office building at 310 Euclid Ave. A steam heating system will be installed in same. Total estimated cost, $2,000,000.

N. C., Kinston—The city plans to construct an electric power plant. Estimated cost, $300,000. W. C. Olsen, Sumter, S. C., Engr.

O., Cleveland—G. H. Greenberg, Atty., Society for Savings Bldg., is interested in a company to be incorporated which plans to build a 1, 3 and 5 story ice palace, commercial building, market house and garage on East 105th St. and Euclid Ave. A steam power plant will be included in the plans. Total estimated cost, $1,500,000.

O., Cleveland Heights (Warrensville P. O.)—The Bd. Educ. voted $2,400,000 bonds, $750,000 of which will be used to purchase new sites, $1,500,000 for the construction of additions to the Fairfax, Coventry and Noble Rd. Schools, a school building on Taylor Rd. and Monticello Ave. and a power house on Lee Rd. Equipment will be installed in the new building project. Noted May 18.

O., East Cleveland (Cleveland P. O.)—The Bd. Educ., c/o C. Ammerman, Williamson Bldg., received lowest bid for the installation of a heating system in the proposed 2 story school on Mayfair Rd., from the Miles Heating & Ventilating Co., Park Bldg., Cleveland, $39,000.

O., Springfield—The Bd. Educ. is having preliminary plans prepared for the construction of 5 separate buildings and additions to 3 or 4 of the present school buildings. Steam heating systems will be installed in same. A $1,000,000 bond issue has been passed for the project. O. D. Howard, 8 East Broad St., Columbus, Archt.

Ind., Anderson—The City Council has passed an ordinance appropriating $350,000 to enlarge the light and power plant.

Mich., Birmingham—The Bd. Educ. engaged Baxter, O'Dell & Halpin, Archts., 1024 Hammond Bldg., Detroit, to prepare plans for the construction of a 3 story school building on Main St. Steam heating equipment, including boiler, etc., will be installed in same. Total estimated cost, $200,000.

Ill., Marseilles—A. G. Zimmerman, Archt., 85 Ninth Ave., New York City, will soon award the contract for the construction of an 8 story warehouse and manufacturing building for the Natl. Biscuit Co., 10th Ave. and 15th St. A steam heating system will be installed in same. Total estimated cost, $800,000.

Wis., Hartford—The Kissel Motor Car Co. is having plans prepared for an addition to the boiler house here. Sterling boilers will be installed in same. Cahill & Douglas, 217 West Water St., Milwaukee, Engrs.

Wis., Racine—Cahill & Douglas, Engrs., 217 West Water St., Milwaukee, are receiving bids for furnishing one 18 x 72 ft. return tubular boiler for the Hartman Trunk Co., Hamilton Ave.

Wis., Racine—Cahill & Douglas, Engrs., 217 West Water St., Milwaukee, are receiving bids for furnishing three 300 hp. boilers and stokers for the Racine Mfg. Co., 6th and Mead Sts.

Minn., Marble—The village is in the market for a 125 hp., 125 lb. pressure marine or locomotive type boiler. Carl Nelson, Clk.

Tex., Bronco—The Lovington Pub. Utilities Co., Lovington, N. M., plans to construct an electric light and power plant, here.

Tex., Houston—The city plans to build a power house, and barn and improve shops, cost, $63,000. Address Mayor.

Tex., Houston—The Houston Lighting & Power Co. plans to construct a 2,300 volt primary service line to West University Pl. Estimated cost, $10,000.

Tex., Toyah—The City Council has granted a franchise to Jesse Knight for the construction of an electric light and power plant.

Tex., Vernon—The Texas Pub. Serv. Co. plans to construct extensions and improvements to its electric light and power plant, here. Estimated cost, $100,000. A. V. Foster, Toledo, O., Pres.

Tex., Wharton—The Texas Gas & Electric Co. will rebuild the electric light and power plant recently destroyed by fire entailing a loss of $100,000.

Okla., Okmulgee—John M. Moore is having plans prepared for the construction of a 4 story, 100 x 100 ft. garage. A steam heating system will be installed in same. Total estimated cost, $250,000. Smith, Rea, Lovitt & Senter, Parkinson Bldg., Archts.

Ore., Portland—Multnomah Co. Hospital Comn. will soon award the contract for the construction of a 5 story, 150 x 210 ft. hospital. The boiler house and laundry are to be in a separate building. Total estimated cost, $800,000. Noted March 9.

Cal., Long Beach—The city received bids for the construction of a sewage pumping plant with pumps, motors, flush tanks, etc., from John Cummings, 1200 Washington Bldg., Los Angeles, $44,650; John Radick, $46,999; Peter Tomick, $57,900. Noted March 3.

Cal., Los Angeles—The Bd. Educ., Security Bldg., received lowest bid for installing a steam heating system in the proposed 1 and 2 story, 132 x 220 ft. school on East 7th St., from Thomas Haverty Co., 8th St. and Maple Ave., $13,850.

Cal., Redding—The Pacific Gas & Electric Co. plans an expenditure of over $3,000,000 on electrical developments in Shasta Co., this season. Plans include the construction of 2 power houses in Hat Creek Valley, each developing 10,000 hp., a pole line from the power plants to Cottonwood and a power plant at Falls River Mills, to generate 68,000 hp.

Cal., Richmond—The Bd. Educ. voted $565,000 bonds to purchase sites, build and equip 6 school buildings.

Cal., Riverbank—The Atkinson, Topeka & Santa Fe Ry. Co., Ry. Exch. Bldg., Chicago, plans to build an ice plant here which will have a daily capacity of 1,000 tons.

Cal., San Diego—The Bureau of Yards & Docks, Navy Dept., Wash., D. C., will soon award the contract for furnishing and installing refrigeration equipment in the Industrial Building at the Marine Corps Naval Base, here. Estimated cost, $50,000.

Cal., Susanville—The Lassen Electric Co. plans an election to vote on a $100,000 bond issue to construct a transmission line from here to Westwood, a distance of 25 miles.

M. I., Guam—The Bureau of Yards & Docks, Navy Dept., Wash., D. C., received bids for the installation of turbo alternators, exciters and switchboard, at the Naval Station here, from the Westinghouse Electric Co., 803 Hibbs Bldg., Wash., D. C., at $33,107; General Electric Co., River Rd., Schenectady, N. Y., at $34,625. Noted May 25.

Que., Shawinigan Falls — The Amas Waterworks Co. will receive bids in June for the establishment of waterworks to comply with the city supply and development of hydraulic power. Estimated cost, $175,000.

Ont., Milverton—The Municipality will soon award the contract for the construction of a pumphouse and installation of a 500 g.p.m. electric driven pump in connection with the proposed waterworks system. E. A. James Co., Ltd., 36 Toronto St., Toronto, Engrs.

Ont., Toronto — The Hydro Electric Comn. of Ontario, University Ave., plans to construct the first unit of a hydro-electric plant, which will have a 37,300 kw., 3 phase, 25 cycle, a.c. capacity. A steam standby of 50,000 hp. capacity will be installed in same. Total estimated cost from $1,500,000 to $2,000,000. F. A. Gaby Hydro-Electric Bldg., Supt.

Ont., Windsor—W. T. Piggott, Dougal Ave. and London St., W., plans to construct a 1 story, 60 x 80 ft. mill on Dougal Ave. Plans include an office building, boiler house and dry kiln. Steam boilers of about 60 hp. capacity will be installed in same. Total estimated cost, $35,000.

CONTRACTS AWARDED

N. Y., New York—The United Electric Light & Power Co., 130 East 15th St., has awarded the contract for the construction of a 1 story, 30 x 100 ft. transformer station on Elizabeth St., to James A. Henderson, 30 East 42nd St. A steam heating system will be installed in same. Total estimated cost, $100,000.

N. J., Verona—The Hospital for Tuberculosis Diseases has awarded the contract for the installation of a steam heating system in the proposed group of hospital buildings, to J. H. Nelles Co., Irvington, at $44,000. Noted April 27.

N. J., Vineland—The state has awarded the contract for the construction of a 2 story, 50 x 75 ft. cold storage and cannery building at the Institution for the Feeble Minded here, to J. Pasquale, Landas St., at $36,000.

Md., Cumberland—The Kelly Springfield Tire Co. has awarded the general contract for the construction of a 3 and 4 story, 575 x 620 ft. rubber tire factory on River Rd., to the Hunkey-Conky Constr. Co., Cleveland, O. Complete equipment for power house, pumping station and main factory building will be installed in same. Total estimated cost, $2,000,000.

Tenn., Memphis—The Memphis Gas & Electric Co. has awarded the contract for the construction of a 3 story substation on Elzey Pl., to be known as the booster station, to E. J. Pearson, U. & P. Bank Bldg. Estimated cost, $25,000.

O., Cleveland—The American Steel & Wire Co. has awarded the contract for the construction of a 1 story, 50 x 130 ft. boiler plant on Lakeside Ave., to the Drummond Miller Co., 4500 Euclid Ave. Estimated cost, $75,000.

Ia., Greene—The School Bd. has awarded the contract for the installation of a plumbing and heating system in the proposed city high school, to the W. D. Reed Plumbing & Heating Co., Kansas City, Mo., at $14,456.

Minn., Owatonna—The Bd. Educ. has awarded the contract for the installation of a heating, plumbing and ventilating system in the high school here, to P. J. Gallagher, Faribault, at $91,833.

Kan., Wichita—The Arkansas Valley Interurban R.R. Co., 126 West 1st St., has awarded the contract for the construction of a 2 story, 80 x 112 ft. interurban station, to the G. H. Siedhoff Constr. Co., 121 Market St. A steam heating system will be installed in same. Total estimated cost, $125,000.

Okla., Carnegie—The city has awarded the contract for the construction of a reservoir and power house and the installation of pumping equipment in connection with the proposed waterworks improvements, to the Ajax Constr. Co., Lawton, at $18,739.

Okla., Duncan—The city has awarded the contract for the construction of a 250,000 gal. reservoir and deep well and the installation of pumping equipment in connection with the proposed waterworks extensions, to N. S. Sherman Machine & Iron Works, 18-32 East Main St., Oklahoma City, at $35,350.

P. I., Manila—The Diocese of Manila, c/o York & Sawyer, Archts. and Engrs., 50 East 41st St., New York City, will build a 2 and 3 story, 100 x 200 ft. hospital building. A steam heating system will be installed in same. Total estimated cost, $600,000. Work will be done by day labor.

Ont., Peterboro—The Canadian General Electric Co., 212 King St., West Toronto, has awarded the contract for the construction of a 6 story electric manufacturing building, to John E. Hayes, 219 Park St. A steam heating system will be installed in same. Total estimated cost, $500,000.